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Flow Forming Lathe Cuts Tooling Costs

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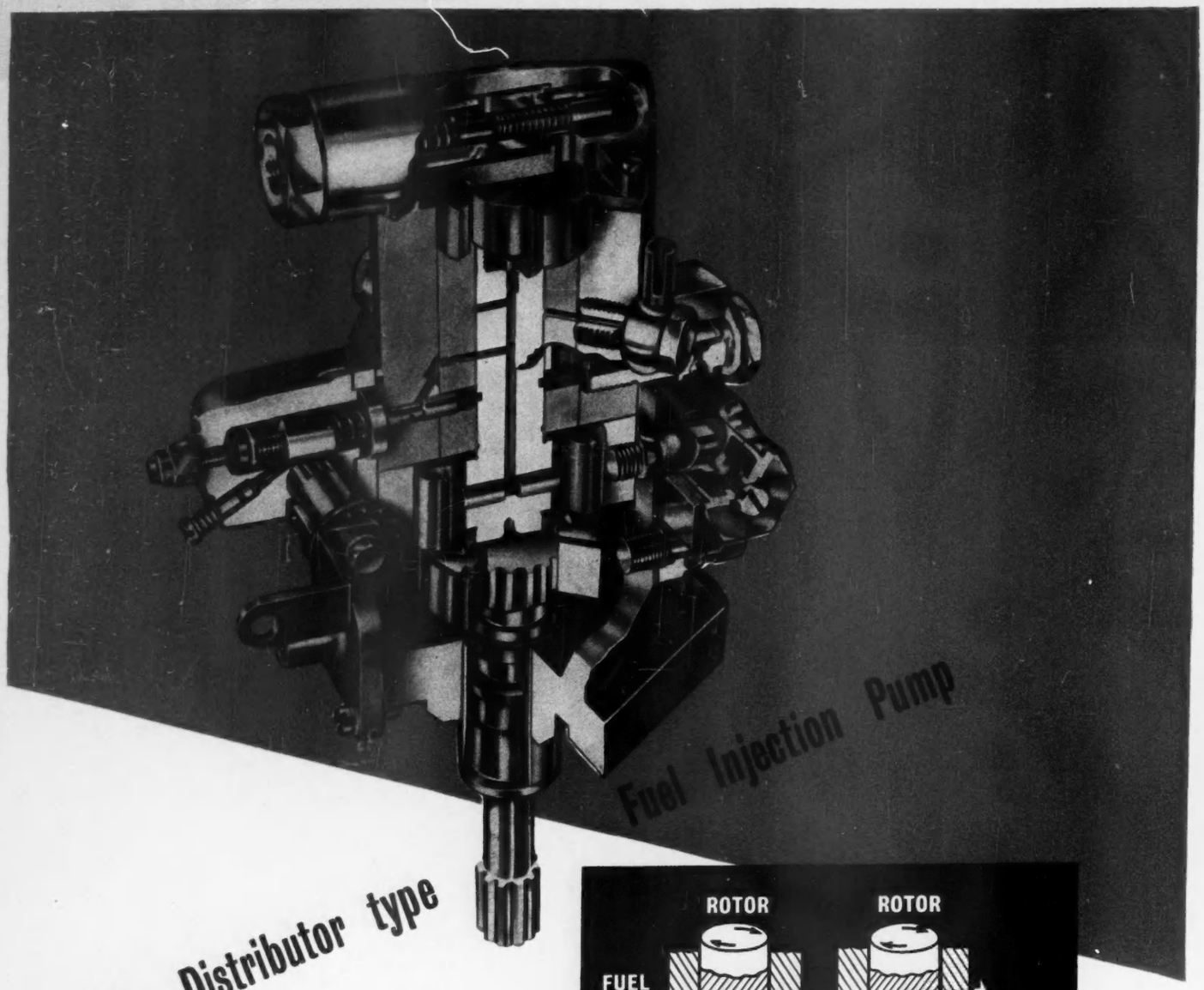
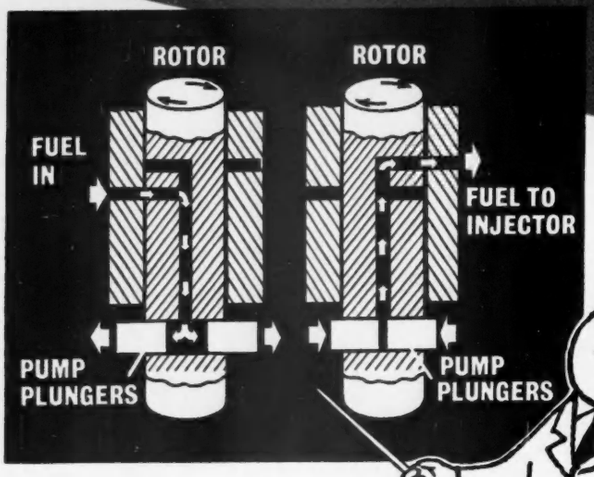
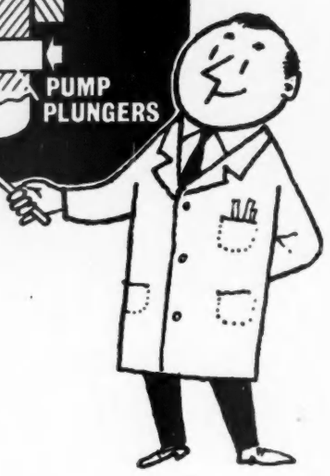


The Distributor type Fuel Injection Pump



THE SIMPLE BASIC PRINCIPLE

The DPA pump is quite simple in operation. It has only ONE pumping element, whatever the number of engine cylinders. Twin opposed plungers carried by the rotor are operated by a cam ring. The rotor is carried in a stationary housing, and drilled ports provide for fuel inlet and discharge. The left diagram shows fuel entering the pumping element on the inlet stroke. As the rotor turns (right), the inlet port is shut and fuel is delivered through one of the connections leading to the injection nozzles. This cycle is repeated for each engine cylinder, the rotor distributing charges of fuel to each outlet in turn. No calibration or phasing adjustments are required.



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AP 961

The POWER of Kincardine

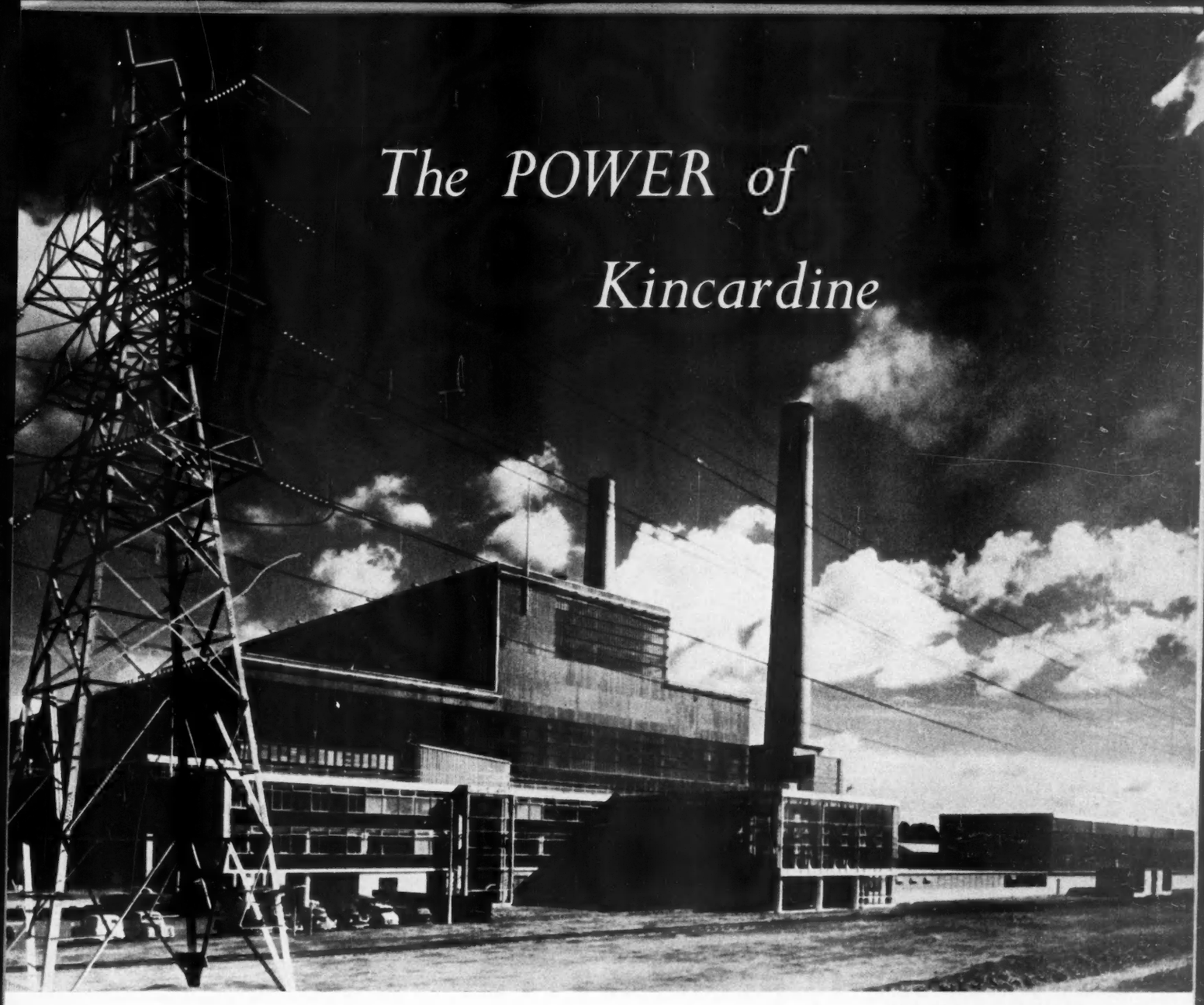
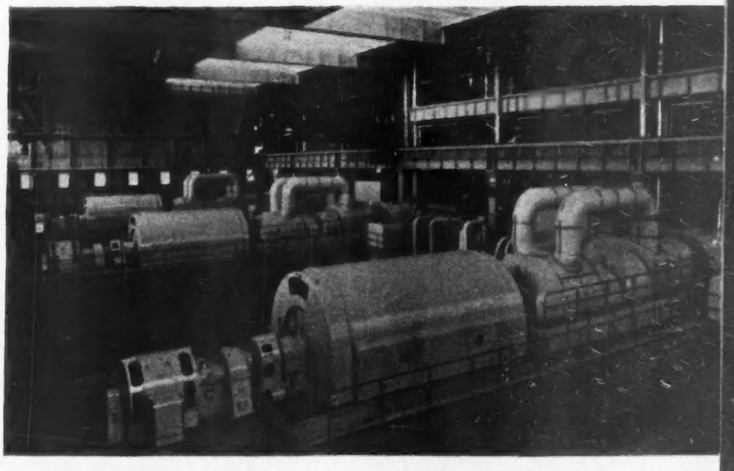


Photo: Holloways Scottish Constructions Ltd.

OFFICIALLY OPENED on October 12th 1960 Kincardine Power Station, on the River Forth, with an installed capacity of 360MW (to be increased to 760MW by 1963) is the largest power station owned by the South of Scotland Electricity Board.

The three PARSONS 120MW turbo-generators now installed operate with steam at 1,500 psig. and 1,000°F with reheat to 1,000°F.



Three PARSONS 120MW turbo-generators installed at Kincardine Power Station

PARSONS turbo-generators

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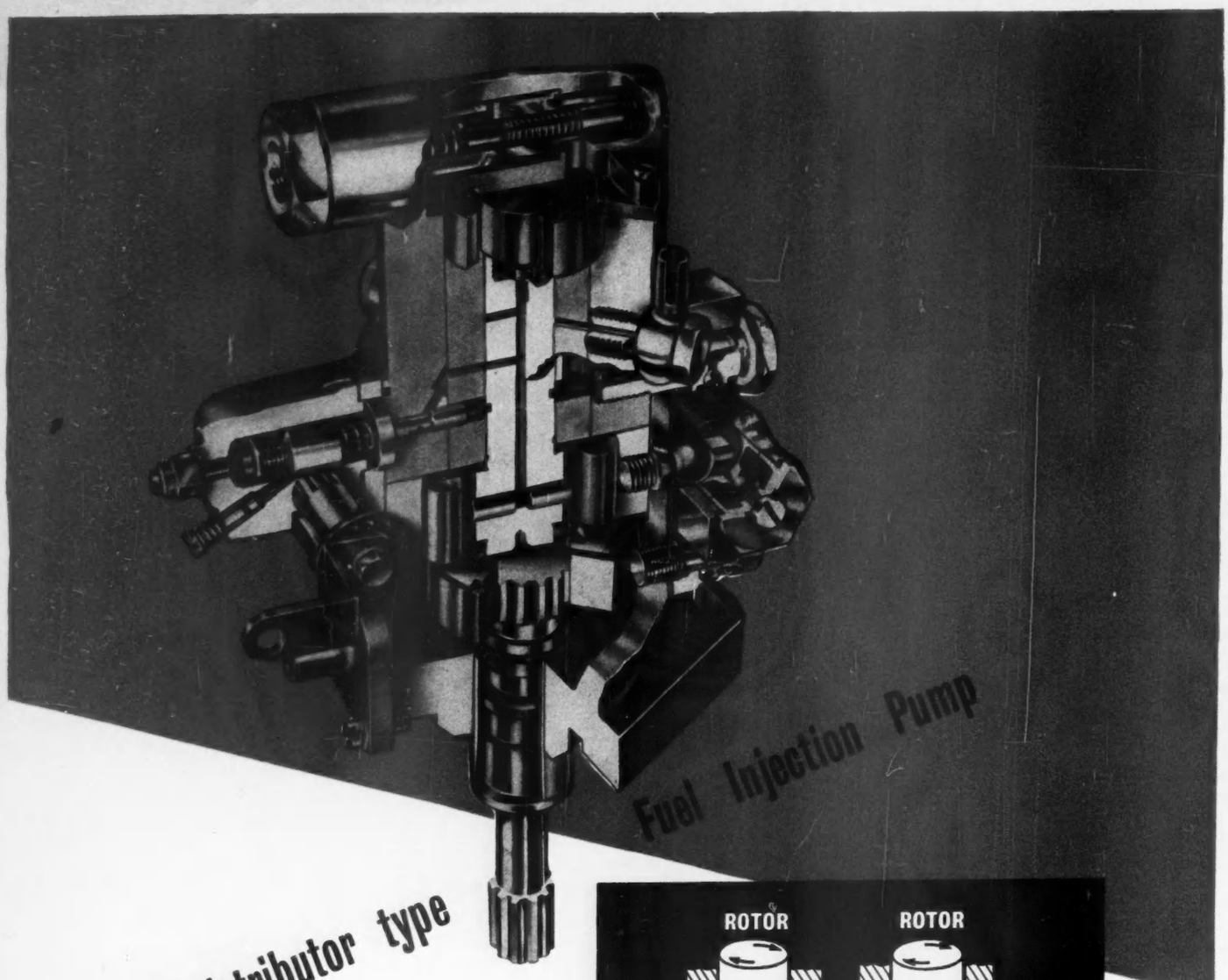

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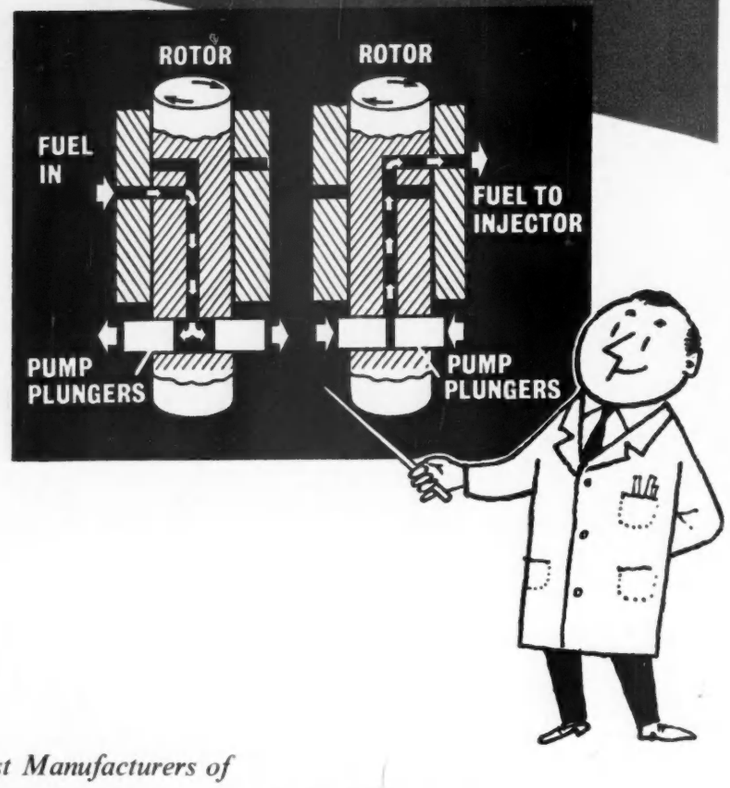

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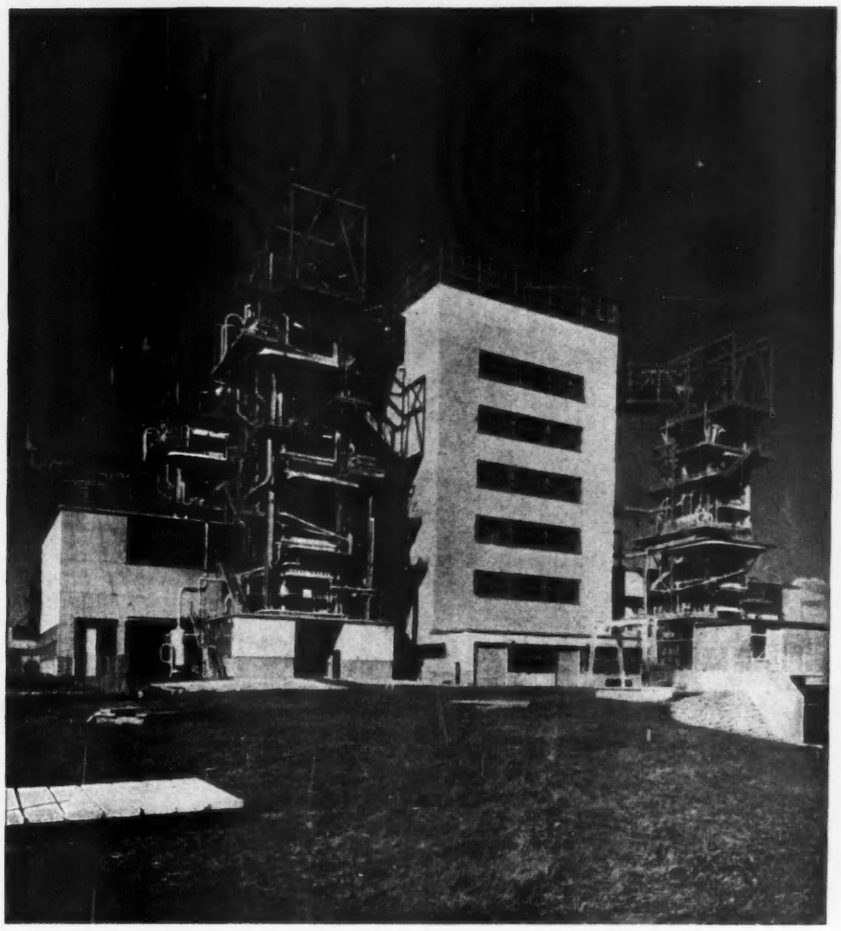

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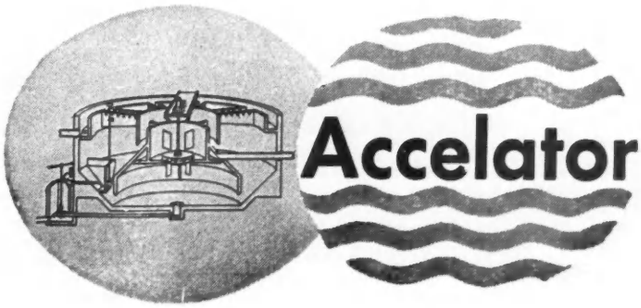

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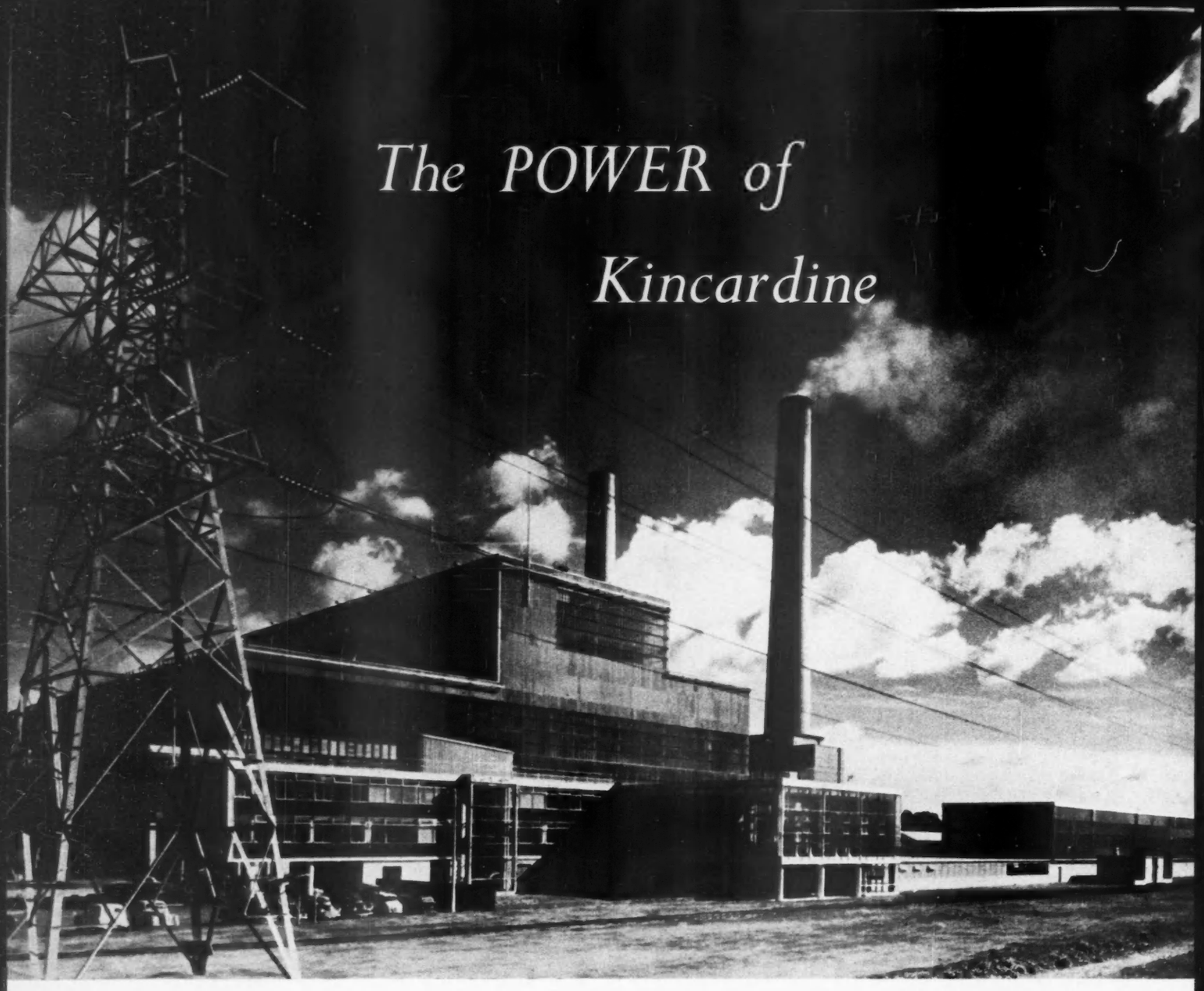

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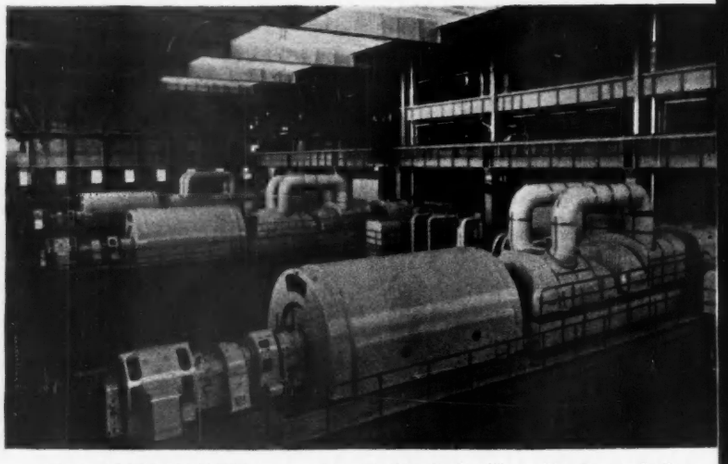

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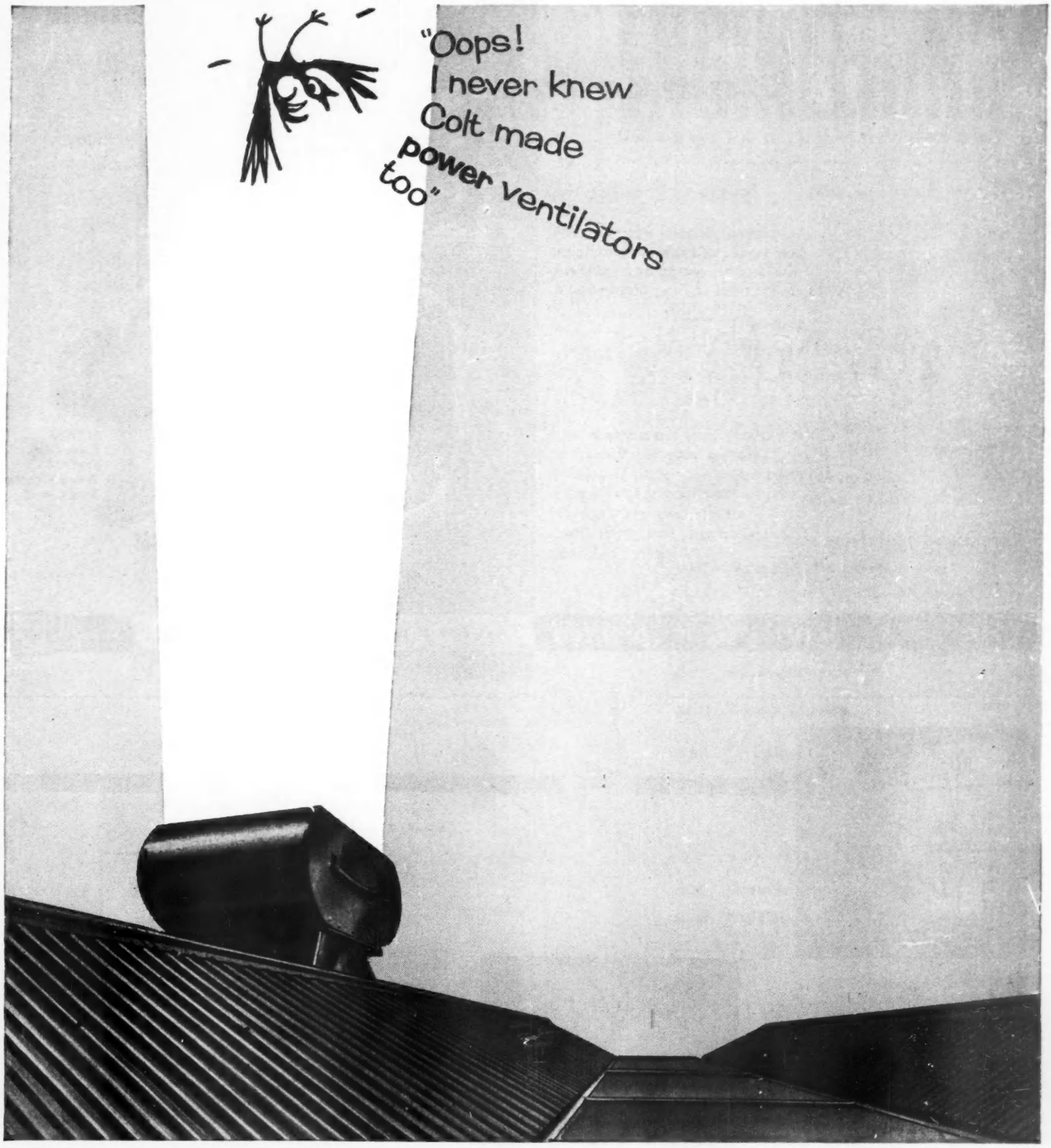

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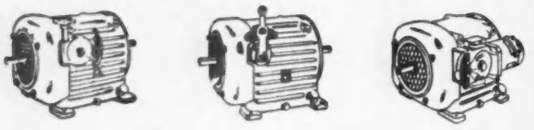

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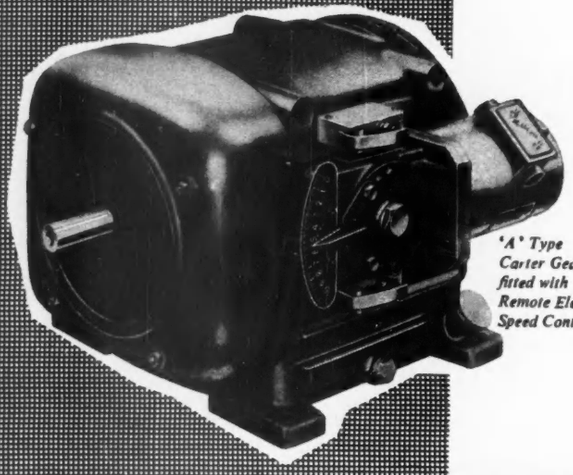

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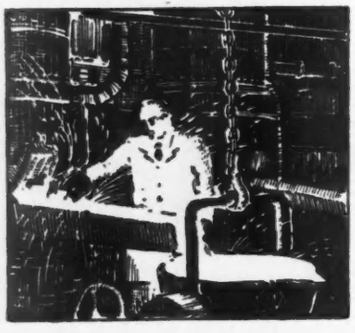

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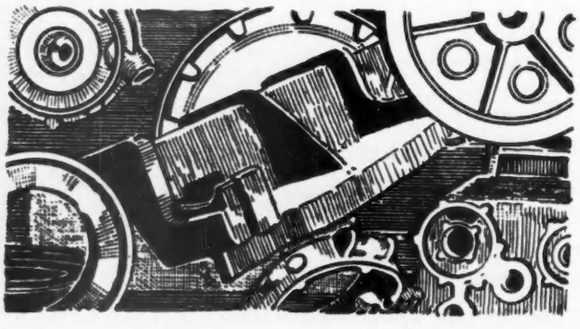

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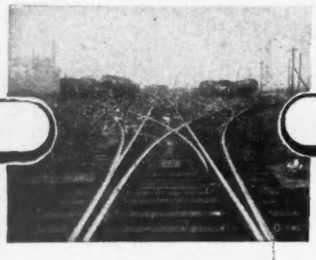

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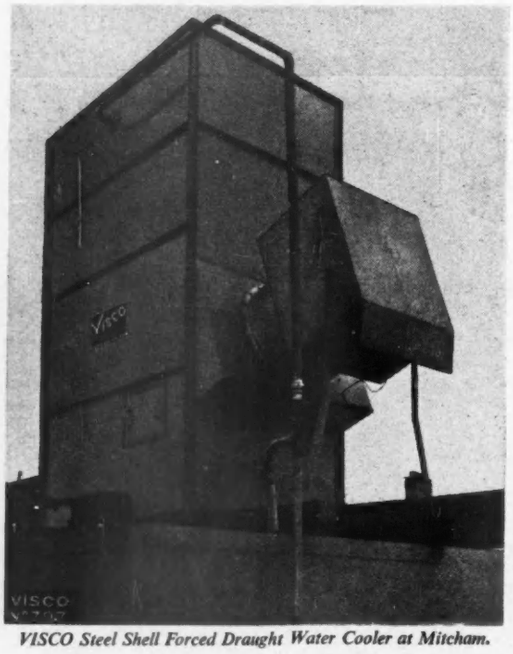

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All applications will be considered by the Board of Entry which may call candidates to attend at the College for written Entrance Examination in Engineering, Physics, Mechanics, and Mathematics, to be held on Monday, 27th March, 1961. Exemption from this examination will normally only be given to candidates possessing 1st or 2nd Class Honours Degrees in Science or Engineering, or reading for Honours Degrees. The Board may also require attendance for personal interview at a later date.

Candidates who possess Bachelors Degrees with 1st and 2nd Class Honours in Aeronautics, and also in Science or Engineering if they have adequate post-graduate experience, may at the discretion of the Board of Entry be accepted for entry to the second year of the course and qualify for the Diploma (D.C.Ae.).

Further information about the course and forms of application, which must be completed and returned not later than SATURDAY, 4th MARCH, 1961, may be obtained from THE WARDEN, THE COLLEGE OF AERONAUTICS, CRANFIELD, BLETCHLEY, BUCKS. D 649

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(4) Supply and place about 120 sq. yds. of new road surfacing.

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Tenders must be received by the CITY ENGINEER, TOWN HALL, NEWCASTLE UPON TYNE 1, not later than 10 a.m. on MONDAY, 23rd JANUARY, 1961.

The Council does not bind itself to accept the lowest or any tender.

JOHN ATKINSON,
Town Clerk. D 653

PATENTS

THE PROPRIETORS OF BRITISH PATENT NO. 759,094, for "A GATE VALVE ASSEMBLY," desire to enter into negotiations with a firm or firms for the sale of the patent or for the grant of licences thereunder.—Further particulars may be obtained from MARKS & CLERK, 57 & 58 LINCOLN'S INN FIELDS, LONDON, W.C.2. D 652

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POWER OPERATED DOUBLE GEARED PLATE BENDING ROLLER. Motorised for 400/3/50 supply. Rollers grooved one end to accommodate wired edge sheets. Top roller bearing caps hinged for withdrawal of cylinders. Approx. capacity 3 ft. by $\frac{1}{8}$ in. Diameter of rollers 4⅛ in. Weight approx. 10 cwt.

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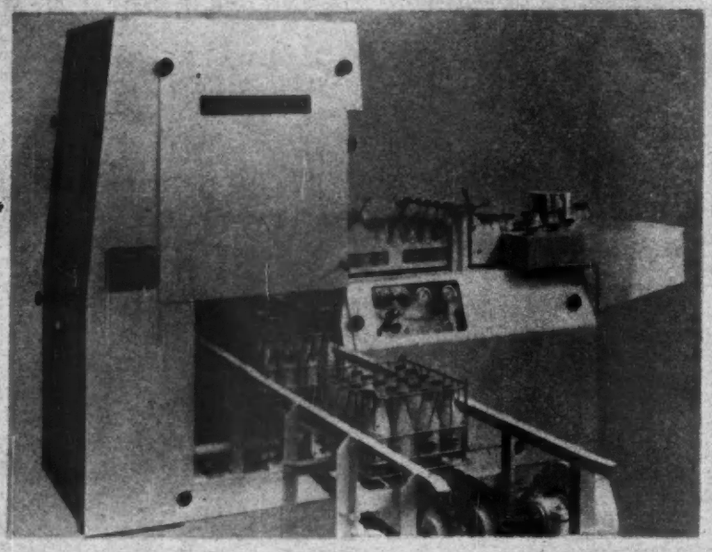

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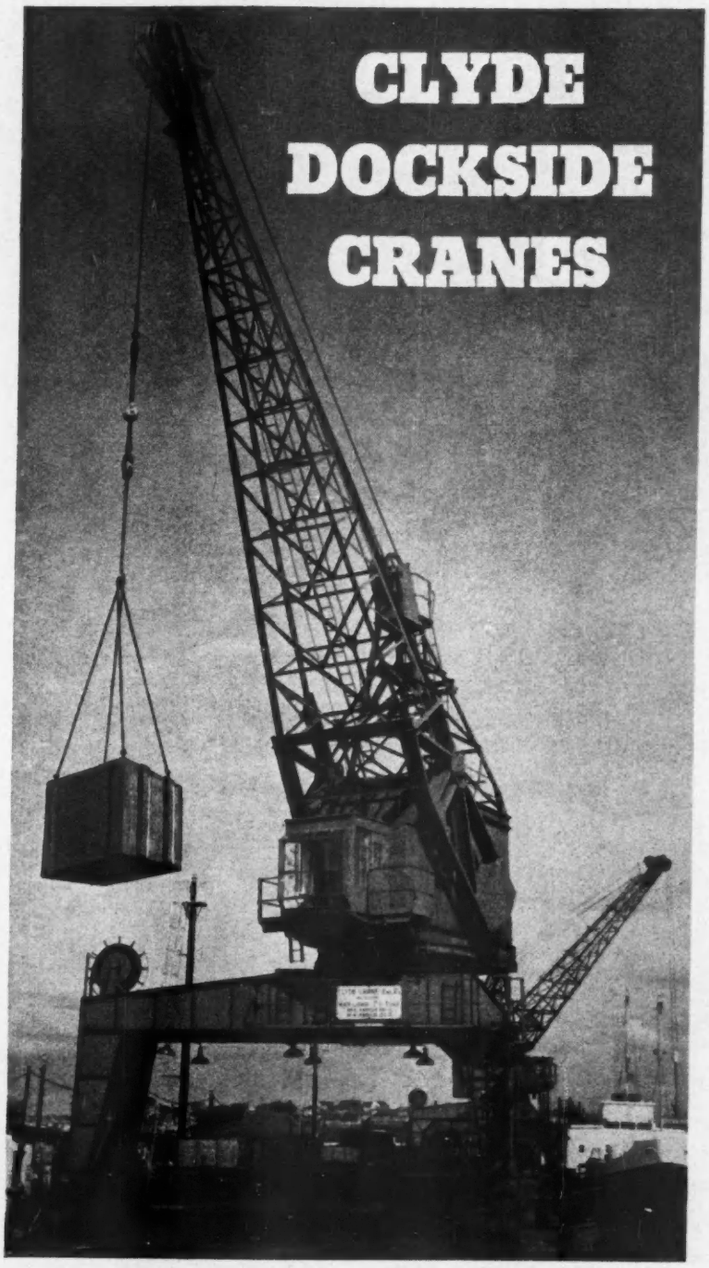

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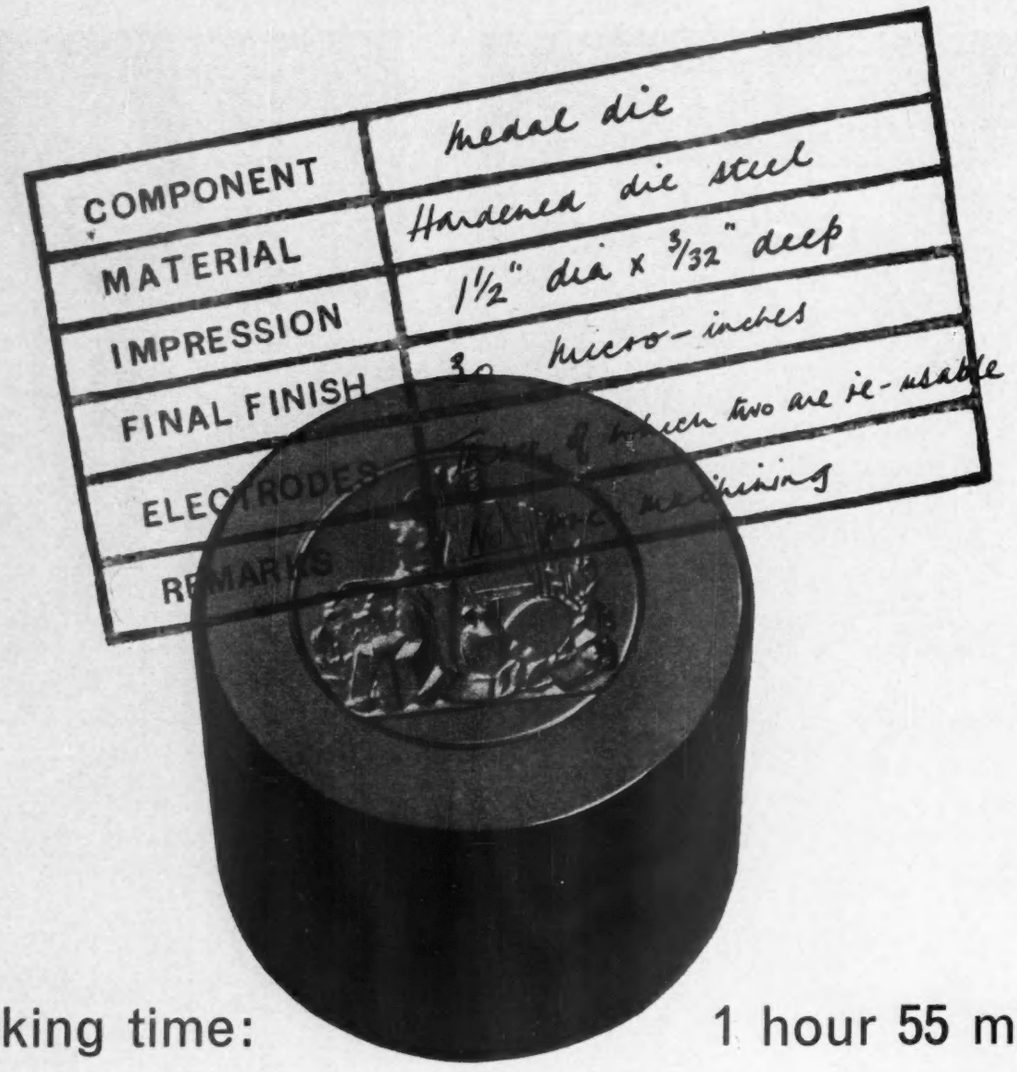

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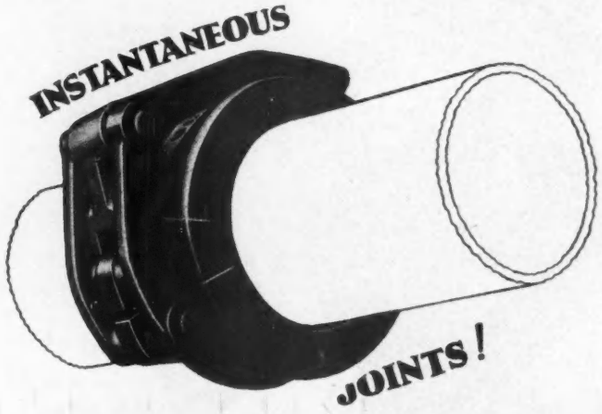

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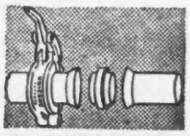
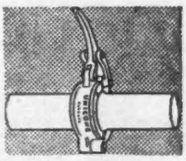
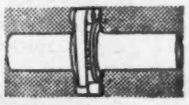

Rubber gasket in position and joint ready to pull over


Pipe ends joined ready for locking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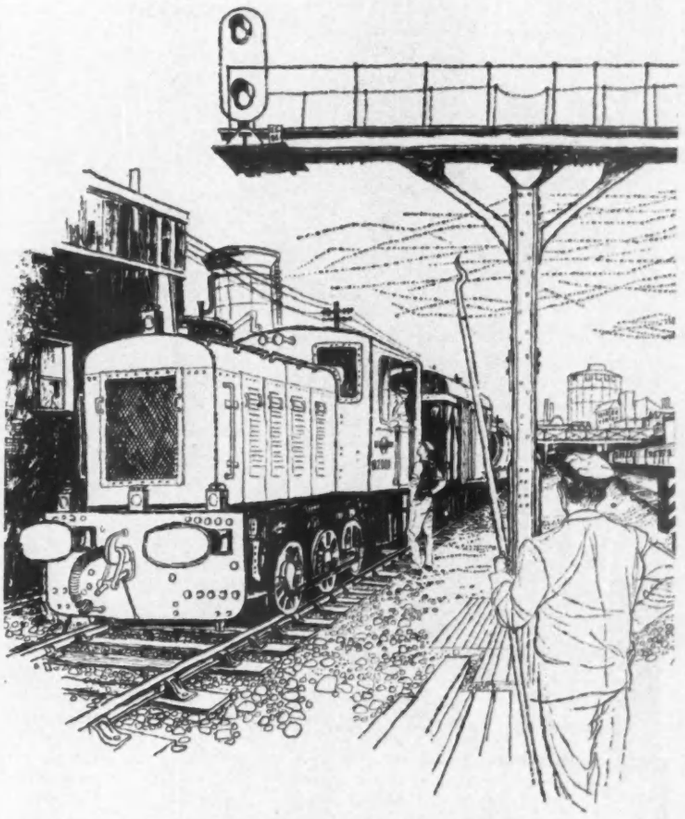

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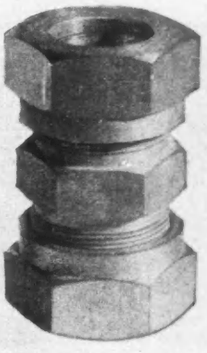

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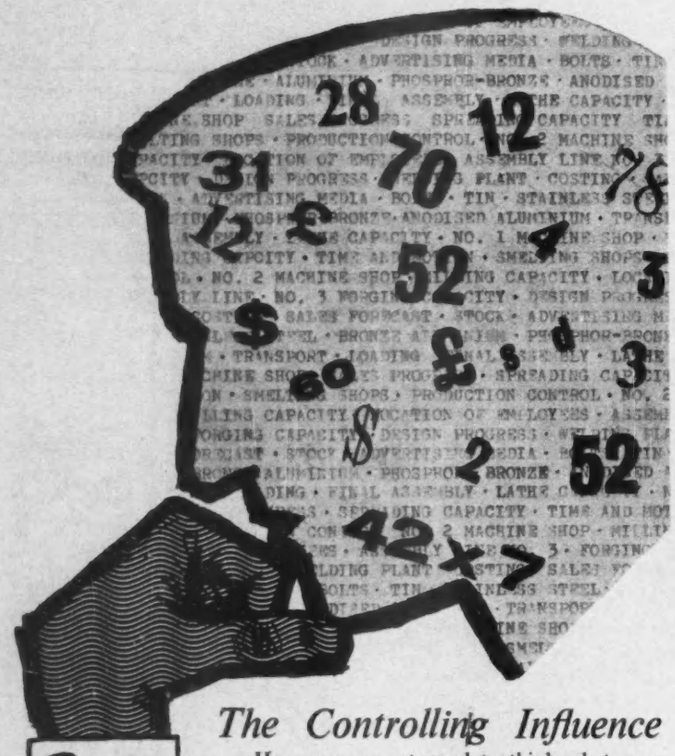

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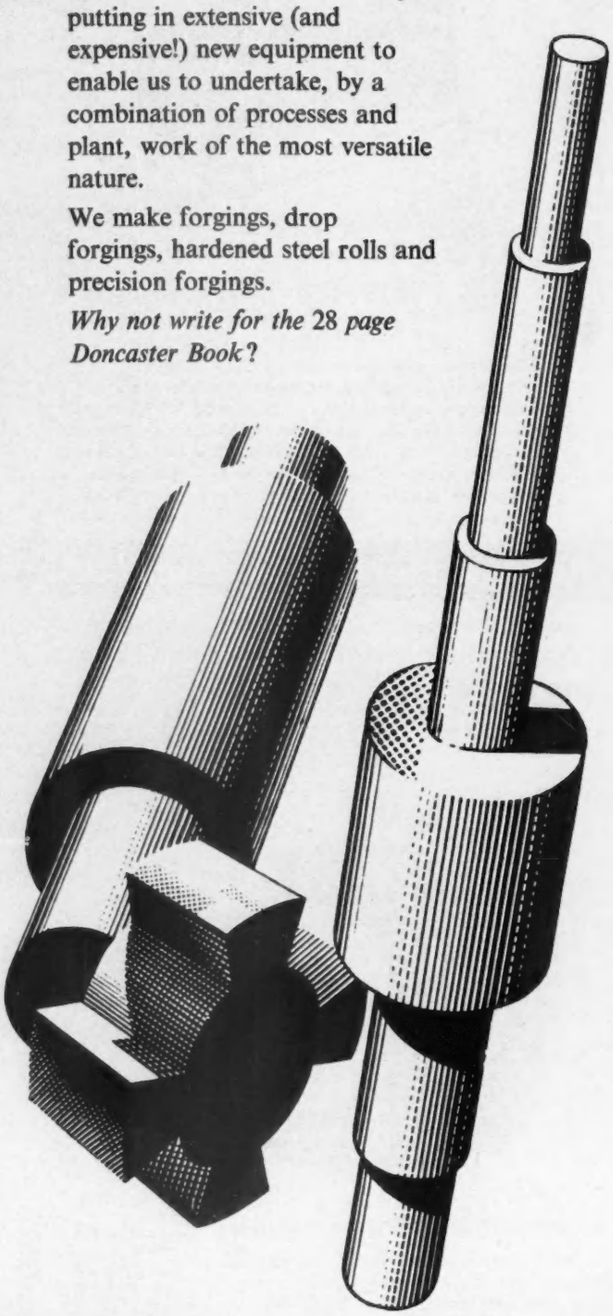

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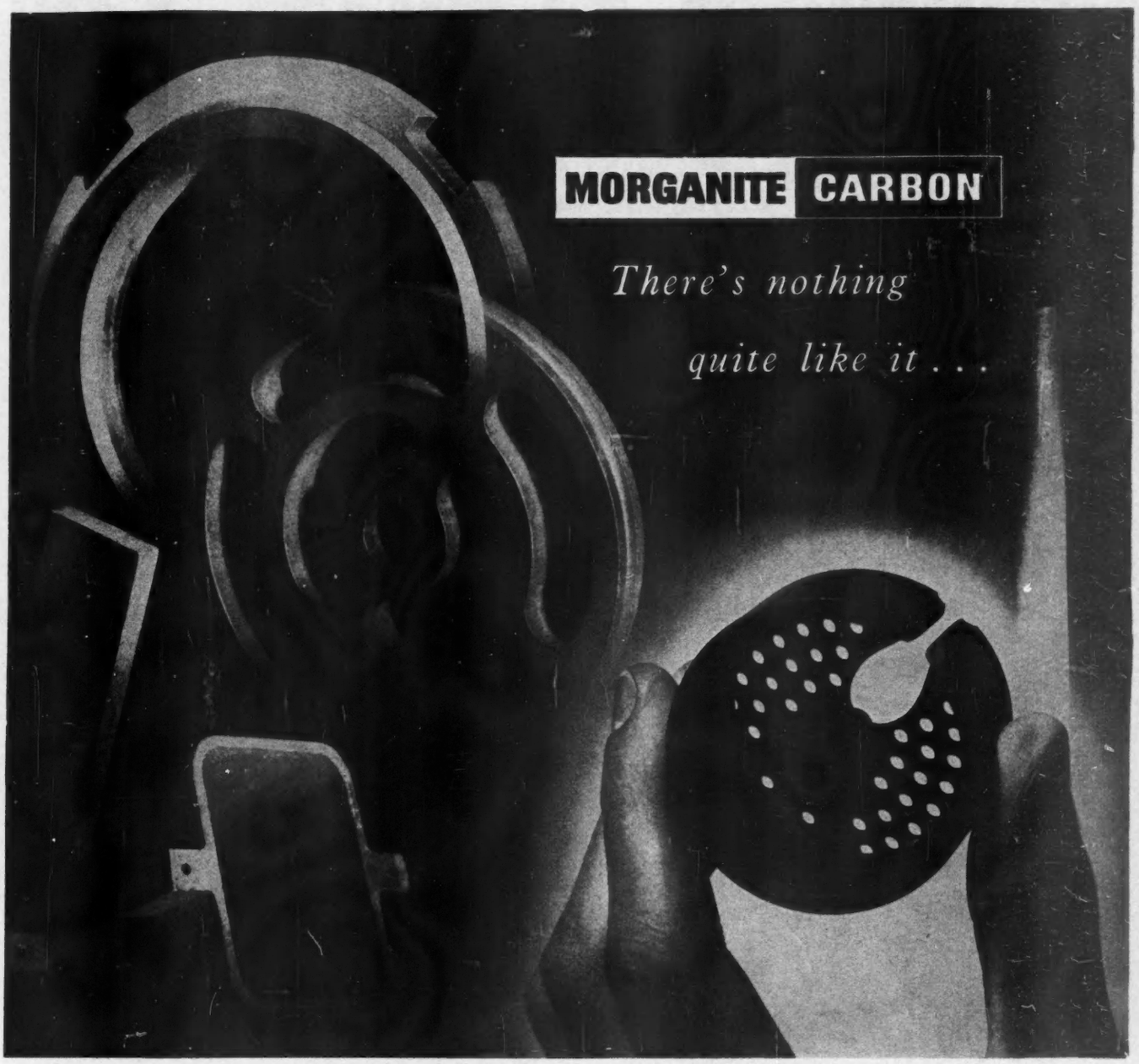

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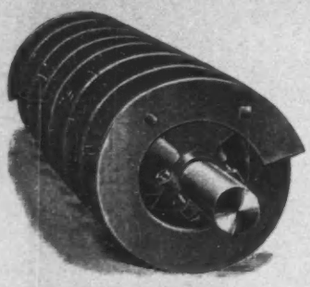

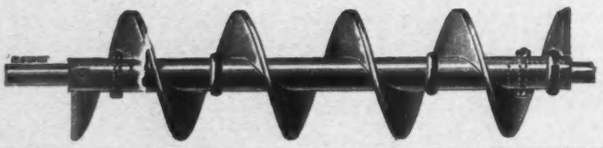

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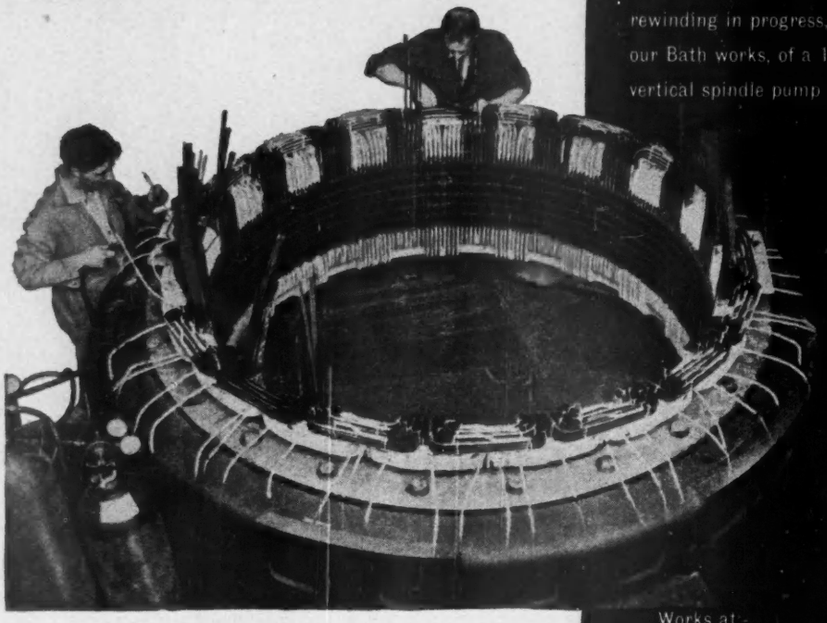

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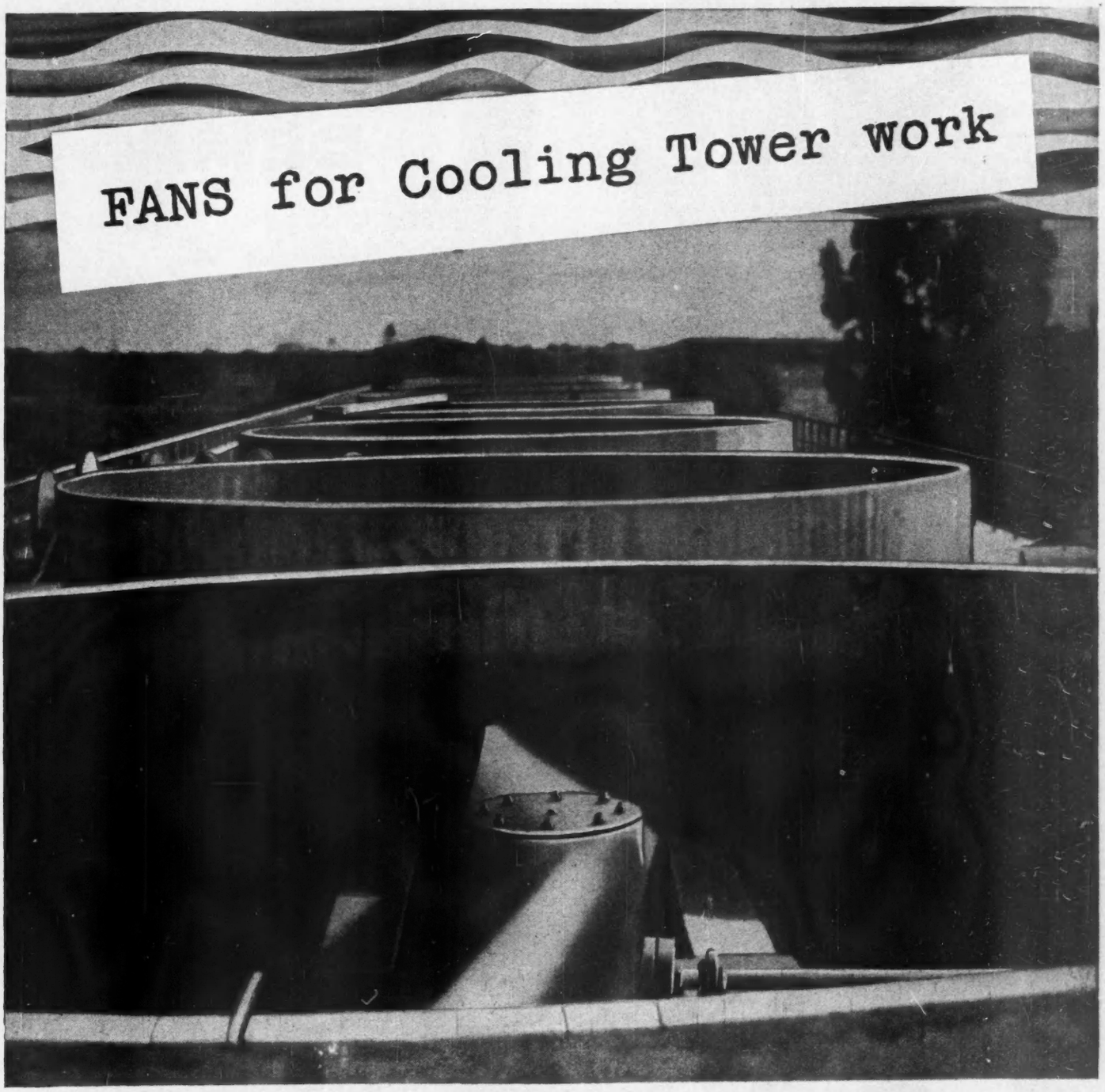

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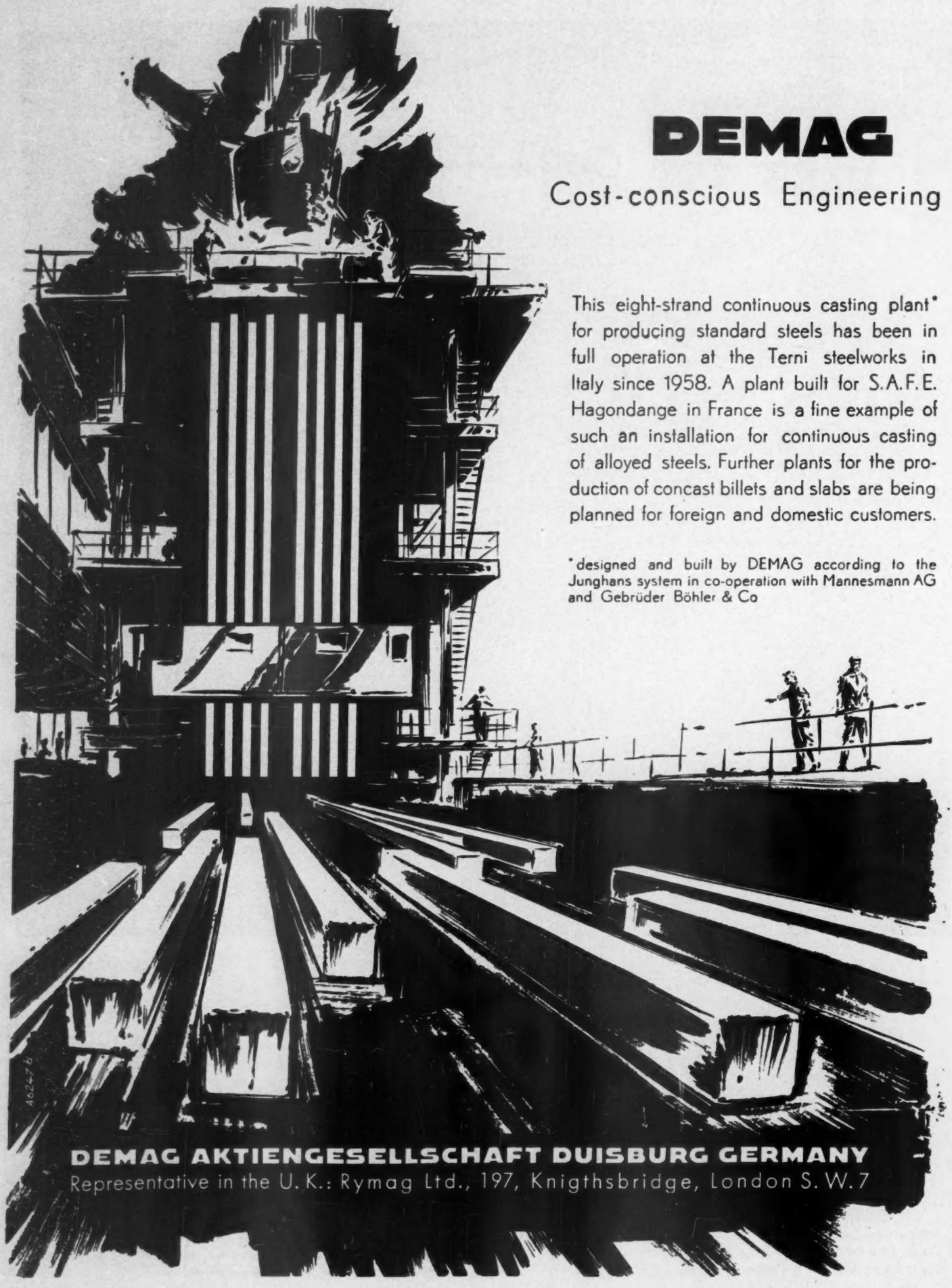

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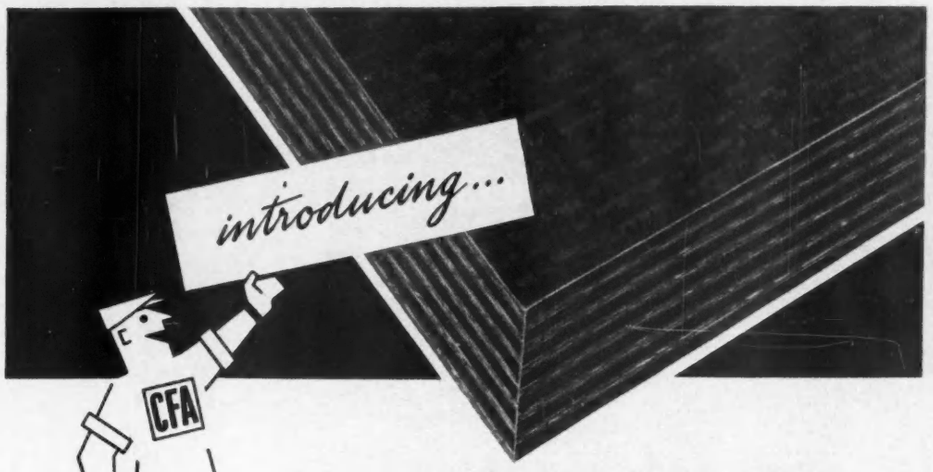

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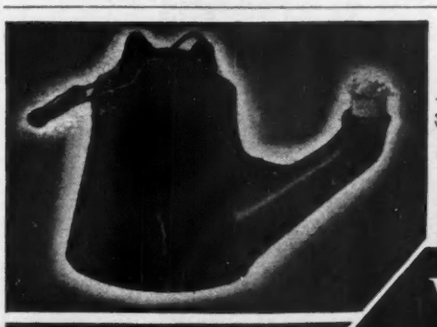

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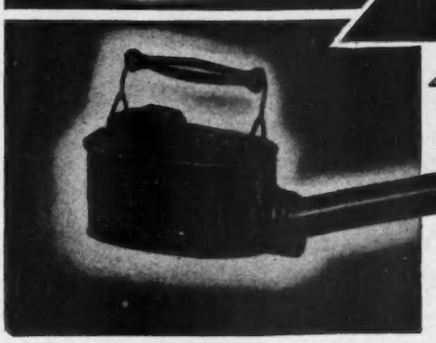

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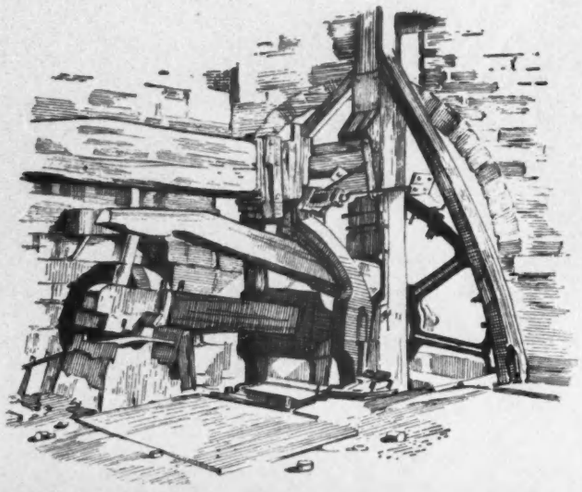

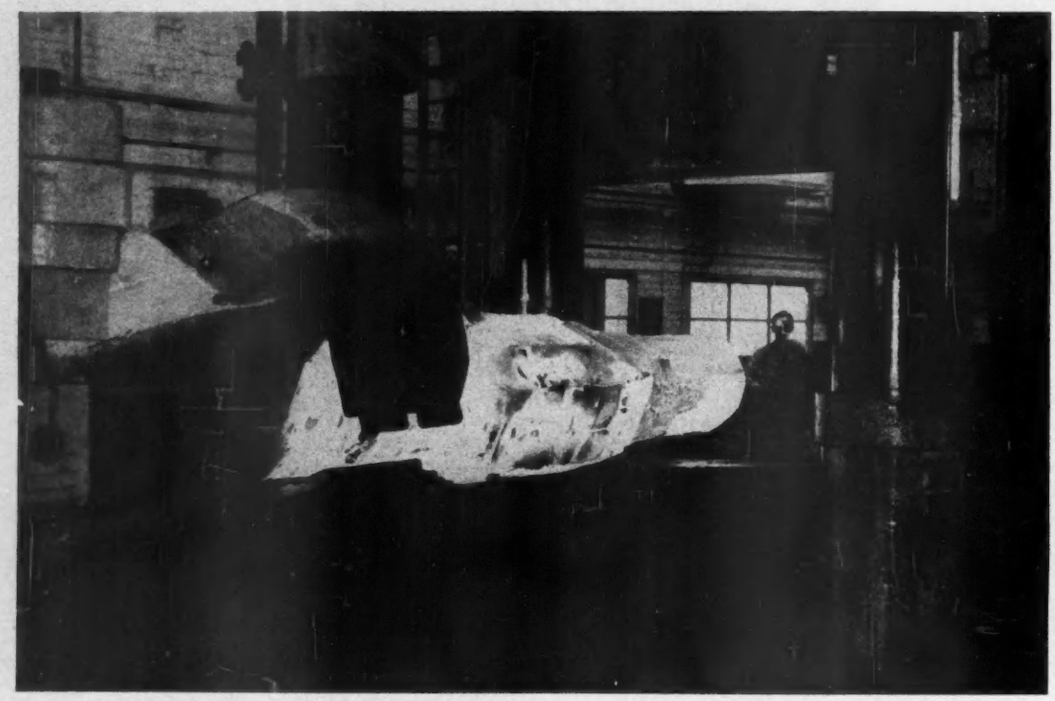

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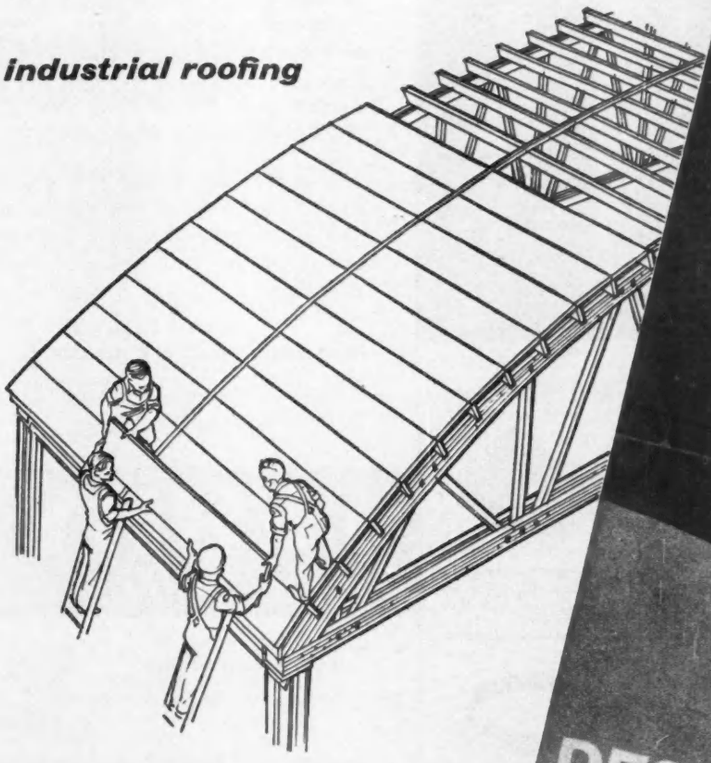

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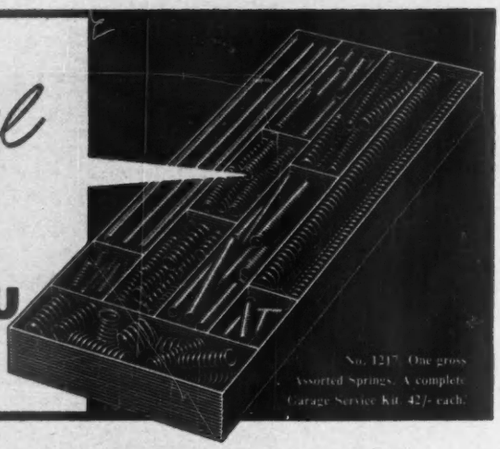

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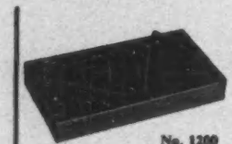

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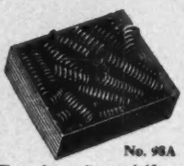

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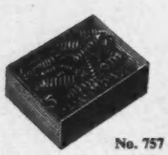

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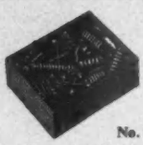

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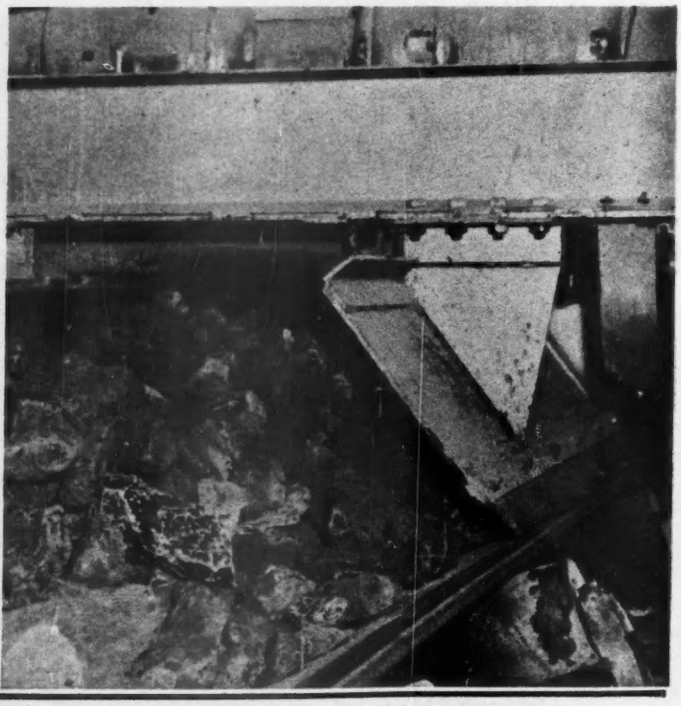

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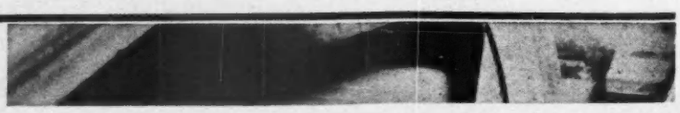


ENGINEERING Impact

of Pulling Together for Economic Advance

THE first and perhaps the most vital of the objectives of the newly formed Organisation for Economic Cooperation and Development, to which belong the 18 members of the old OEEC plus Canada and the United States, is the achievement of—

> *the highest sustainable economic growth and employment and a rising standard of living in the member countries while maintaining financial stability, and thus to contribute to the development of the world economy.*

This is an admirable aim but not one on which the Governments of, say, Great Britain, the United States and West Germany can be expected to see eye to eye. The United States administration, moving towards policies of expanding industrial activity under a new President, West Germany with its towering export surpluses, and Britain with its grim trading deficit are moving on three different tracks, whatever the public speeches.

Booming Europe

West Germany's export surplus for this November reached DM 571 million (£48 million) an increase of a third over the October figure, although not as high as the DM 680 million surplus of November, 1959. For Western Europe in general the United Nations Economic Commission for Europe was able to report in its last bulletin that its economy was still enjoying boom conditions in the closing months of the year.

Inflation and over-demand have not materialised in Europe on anything like the scale that had been feared earlier in the year. On balance it looks as if production for consumer markets and for capital investment will go on increasing in Western Europe into 1961 without upsetting the favourable position of the balance of payments.

For the United States the hope is not that inflation will be avoided and expansion maintained but that deflationary trends will be reversed and unused industrial capacity brought more vigorously into play. Expectations that December holiday buying would go to unheard of heights and give some ground for higher hopes among the predictions for 1961 have been disappointed.

High Cost Dangers

For American manufacturing industry the problem, as with other high cost countries, is essentially one of productivity. Warnings that it is possible to price goods out of the US home market as well as out of the overseas fields cannot entirely be countered with the use of protection.

Through the old OEEC decade United States capital flowed into Western Europe. Through the OECD decade it is going to be goods and services that the United States will want to contribute to Western Europe and Britain.

A quick look at the figures shows that as the European Common Market nations give each other increasingly favourable treatment, and as their highly modernised factories work flat out on long production runs, the prospects for United States exports to this fast growing market depend very heavily on reductions in manufacturing costs.

The second of OECD's main objectives is to assist the economic expansion of member and non-member countries who are in the process of economic development.

This is not a job for a debtor nation. As leader of the Commonwealth and from her special historical position, the United Kingdom is particularly well placed to assist the nations emerging from dependence and poverty. But to do so on a greater scale than at present it will first be necessary to reverse the present excess of imports over exports.

In order to maintain home prosperity and to fulfil this role abroad, earning an export surplus on a level with that of West Germany is the United Kingdom's first target for 1961.

Notting Hill Gate Changes Paying Off

London Transport Executive have proved with their redesigned Notting Hill Gate underground station that increasing the convenience and efficiency of a station substantially improves the number of people making use of it.

Since the new Notting Hill Gate station, on the Circle and Central lines of the Underground service, was brought fully into use five months ago the number of passengers using the station has risen from 9¾ million to 14 million a year.

The biggest single snag about the old station was that passengers transferring from one line to the other had to come up to the surface and brave the traffic chaos before going down to make their connection. Now there is a direct link between the Circle and Central line platforms and the number of passengers changing trains at the station has risen to over 16,000 a day, or from 2¼ million to 5 million a year.

More passengers, at the rate of well over a million a year, are using the new station, not including the people who now change there instead of at Holborn, Tottenham Court Road and other stations that were used in preference to the awkward change at the old Notting Hill Gate.

Two Examples

So London Transport not only generates new custom at Notting Hill by its million pound improvement but eases conditions for travellers at many other stations on its lines.

The new station, something of a showpiece with its contemporary decor and careful planning according to passenger-flow calculations, moves its travellers through subways under the main road and on three banks of escalators.

The power of modernisation to attract outstanding numbers of new passengers was also demonstrated on the Glasgow suburban electrified system before the unhappy withdrawal of the new equipment following technical troubles. The new electrified services had raised the numbers they were carrying from 170,000 to 400,000 a week, and under cleaner conditions, before the temporary difficulties arose.

The success of Notting Hill Gate and the promise of the Glasgow suburban scheme indicate what a splendid future is attainable for a fully modernised railway system.

of Fresh Minds in Railway Engineering

What will be the pattern of development of British Railways in the future? In particular, will the new structure for the nationalised transport undertakings, which the Government are planning, quicken or retard the pace of technical development?

The technical development of railways, though important (and of continuing interest to countless engineers and non-engineers), is subsidiary to the commercial function of the railways. Thus, for example, the improvement of locomotive design should not be something exclusive to locomotive engineers, but should be determined by the commercial aim of providing a steadily improving transport service for freight and passengers. And if the railways are considered to be the proper authority to introduce and manage new forms of transport—such as pipelines—then railway engineers must have a breadth of outlook and experience wider than most of them have had in the past.

The Government's proposals will return some of the old autonomy in technical matters to the new regional railway boards. Provided necessary standardisation is not jeopardised, this should encourage greater technical liveliness.

By having a strong Railways Board, controlling the regional boards, as proposed by the Government, it will still be possible to post engineers from one region to another. This facility should also promote technical developments.

On the other hand, the Railways Board is to be responsible for research. There is a danger here that if the engineer members of the Board and the senior staff engineers are all men of long railway experience, there will be a lack of fresh thinking in research. If research is to pay off in such a vast organisation as the railways, it will be desirable to have at least a sprinkling of first-class engineers who are brought in from other industries. On this point the Government have said that, "as far as possible, the nationalised transport undertakings should produce their own leaders." They have also said that "at the outset some major posts may have to be filled from outside." What actually happens in practice will be watched with interest.

The Rise and Fall of Industrial Fortunes

It is a simple deduction from the stationary industrial production index of the past nine months and the intense activity in the production of capital goods for industry that some concerns have been doing very much better than others.

Official estimates of the capital investment of industry show a 33 per cent rise in the third quarter of the year compared with the third quarter of 1959. In the second quarter, the comparative increase was 17 per cent and in the first quarter it was 12 per cent.

The leaders in spending on plant and machinery are the iron and steel and vehicle building companies. Iron and steel, vehicles and textiles are responsible for the greater part of spending on factory buildings.

With steel production now up to an annual rate of just over 26 million tons (average output in November topped 500,000 tons a week for the first time) it is plain that, with the still maturing developments of the steel industry, the production capacity is there if the companies selling overseas can break through against the international competition in the coming year.

Of the relative positions within British industry, the Treasury, in its latest *Bulletin for Industry*, describes the oil refineries, chemicals, vehicles and metals as the pace-setters up to the third quarter.

Taking a closer look at the engineering industries, capital goods production has gone on mounting while production of consumer goods has fallen sharply due to the weakening home market, exports under this heading being small.

and Another £60 Million on Manufacturers' Costs

The wage increase of between 7*s* and 8*s* 6*d* a week for over three million workers in the engineering industries, which took effect from 26 December, raises three problems, each of them with some degree of urgency.

First in importance to the engineering industries is the cost. An extra £60 million in a full year has been added to the costs of production. In some sectors production is high enough and re-equipment going on fast enough for the raised labour costs to be absorbed, although absorbing greater labour costs effectively reduces earnings that could have gone into further modernisation.

But by no means all the engineering industries are in this happy position. Increased labour costs for the car firms, already faced with the judgment against their marketing agreement, will either mean higher manufacturing costs, since capacity is far ahead of demand, or it will mean one more turn of the short-time screw.

For the shipbuilding industry there is an added complication. As Ted Hill, the Boilermakers' leader, has pointed out, a position can now arise where one skilled man, given an increase under the engineering unions' agreement, may be working alongside a man covered by the shipbuilding unions who is on the old, lower, rate. So far the shipbuilding employers have rejected the unions' pay claim.

Thus the shipyards, whose economic plight is obvious, are the victims of a way of negotiating wages that is as anachronistic as it is crude. Not only are the prosperous lumped in with the ailing, which perhaps in a tough, competitive world is right, but whole industries are brought together willy-nilly. In this case an award which will have one effect on the makers of, say, textile machinery, will be found putting up the rates in the shipyards, with quite different results.

The third outcome of the agreement for engineering industries workers is that the joint body of the unions is to press for a revision of the industries' wage structure. The wider the basis of any talks that take place the better.

What's Been Happening in Precoated Strip

Getting on for a year ago, this journal published a review of all the firms making precoated sheet and strip (18 March '60, pp. 374-75). The opinion was expressed that, though very promising, such prepainted and pvc-coated metal products were really " teasers " in that they needed considerable thought on how best to use and fabricate them. Though this point was contested in correspondence by a firm, it does seem to be borne out by comments of other people who offer these materials; and certainly, the tonnage use of the materials is not yet large. But new people have entered this field and some tests on weathering have been performed, so these are two indications of trade confidence in the products.

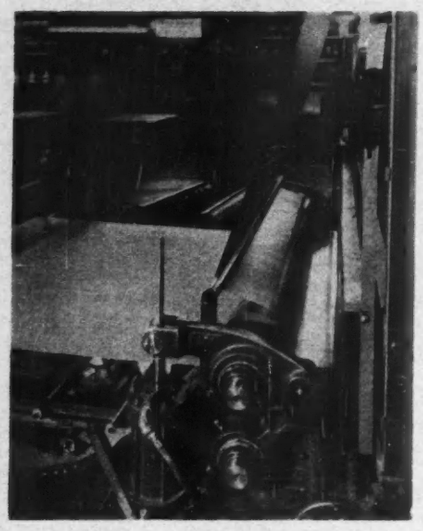
But down to details. Two firms have entered the market for prepainted strip in the United Kingdom. They are Metalon Steels up in Sheffield, whose speciality till now has been electrogalvanised steel, and Hunter Douglas who are well established in the USA and have a production plant in Holland.

Metalon's prepainted strip is called Colmetic and can be bought in coils with thicknesses from 0·004 to 0·048 in and widths up to 18 in. Edges of strip can be coated, but normally it will be slightly cheapter to obtain non-standard width strip which has been edge sheared after coating. Hunter Douglas Holland are really the people behind the entry of the Hunter Douglas organisation into the UK, though people are invited to write in to Hunter Douglas (Great Britain) for literature. This firm sell their product under the name Luxacote, and it should already be known quality-wise on the merits of Luxaflex blinds which are made from this material. Hunter Douglas completed a market survey way back this year and have started a pilot advertising scheme. The width in which Luxacote will be offered is 12 in maximum.

Prepainted strip has a coating thickness usually less than 0·001 in, and though resisting bending and light drawing operations, one needs to look for coatings ten times this thickness before real abrasion resistance and corrosion resistance is obtained—the sort of protection needed for outside panels.

Now to what has happened in this pvc-coated line (for pvc is the most widely used plastic on these materials). Metalon have entered this field with a material called Plasmetic which is made by sticking pvc film on to electrogalvanised steel. Width once again is 18 in, but minimum steel thickness is 0·008 in and pvc thicknesses of 0·004, 0·008 and 0·014 in can be applied. In other words, this is similar to products already on the market.

Dorman Long entered the market only a few weeks ago when they launched their PC sheets for the main application of outdoor cladding. This raises an interesting point because, up till now, the weatherability of pvc in any form has been in question. What is more, they use a plastisol process, in other words, one in which the pvc is applied as a paste which is subsequently baked on. No matter how complete the baking, it is generally true that such coatings finish up softer than coatings which can be



This is an American company's set-up for laminating pvc film on to metal strip. Note how roller pressure is obtained.

applied as film, because it is difficult to drive off all the plasticisers used in making the paste. So in one swoop Dorman Long express confidence in pvc coatings for outside use, and in soft ones at that. If their favourable laboratory weathering tests are borne out in practice, this might increase exterior use of pvc-coated steels because the cost is unlikely to be as high as for film-laminated products. The base steel, incidentally, is galvanised.

John Summers have fought back in the cladding line by recently introducing Stelvetite G based on their electrogalvanised Galvatite. This material itself can now be obtained in large sheets for cladding—up to at least 22 ft long. On the question of weatherability, the company can quote that the LCC approved the use of their material in a block of flats in Stepney, but it is not yet clear what can be read into this.

To justify putting the photograph in this note, one must mention an advance made in America by the Simoniz Company who make a pvc-coated steel under the name of Clad-Rex. Not only is their improved material of interest, but their plant for lamination bears looking at twice. The illustration shows a close-up of the entire laminating production line. Here the pvc meets the metal for the first time. The metal, already cleaned, bonderised and coated with adhesive (nitrile-phenolics have been developed in the UK for this purpose) is emerging from the heating ovens. Pvc is fed from a roller above and meets the hot metal where it is bounded between rollers, the pressure apparently being applied hydraulically. The result of this company's development has been a product which will not only withstand any drawing operation (up to 9 : 1 ratio) which the steel will withstand, but will also resist delamination if heated up to 200° F immediately afterwards.

The final precoated product of importance is one made by Robertson Thain. This firm apparently ran into a number of people who thought that " molten bitumen which falls from a protected metal sheet in industrial fires is one of the factors in spreading fire among combustible contents at ground level." Protected metal sheet was their description of a cladding material which employed bitumen to bond on an asbestos sheet (to which a top coating of resin was applied). They are now withdrawing this from the market in favour of their improved product in which a zinc layer replaces bitumen. Known as Colour Galbestos, this product comes in many colours and corrugations which permit very striking buildings, especially industrial ones, to be constructed. They are also introducing a slate-grey version of this material, one of the colours which is given a Class I spread of flame rating under Fire Research Station tests.

Metalon Steels Limited, Short Heath, Willenhall, Staffs.

Hunter Douglas (Great Britain) Limited, 33 Sloane Street, London, SW1.

Dorman Long and Company Limited, Ayrton Sheet Works, Middlesborough.

John Summers and Son Limited, Shotton, Chester.

Robertson Thain Limited, Ellesmere Port, Wirral, Cheshire.

Hair is a New Packaging Material

Hogs hair is resilient stuff and it's no new idea to make packaging material from it. But the way this is turned into a three dimensional structure which exploits this resilience has needed quite a little thought. Just 18 months ago, one manufacturer, Xetal Products, introduced a new adhesive and launched a material based on curly hogs hair—called Tuflite. Now, Hairlok Company, who also make a range of rubberised hair cushioning materials, have improved techniques and have managed to introduce a crimp into the hair.

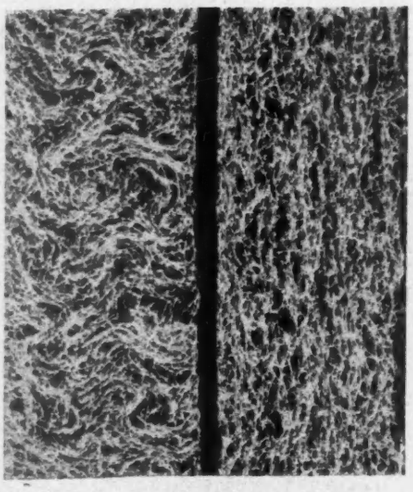
The illustration shows the lie of the hairs, the new one called Texlite being on the left. What follows are the company's comments on their material. Not only is the original curl of the hair preserved but a crimped structure is developed through a needling action. This gives Texlite exceptional resistance to stratification and a resilience never before achieved in high density rubberised hair.

Better protection is afforded by 1 lb of Texlite than by 2 lb of ordinary rubberised hair. After 30 consecutive drops from a height of 4 ft 6 in, the shock transmitted to the Texlite protected pack increased only by approximately 10 per cent. Saturation of the material with water even improves shock attenuation slightly. It should prove the ideal cushioning material for the packaging and transportation of electronic and other delicate instruments, control equipment, and fragile electrical apparatus among many items.

Batch production is available now and mass production will start in January, 1961. Standard densities are 4 lb and 6 lb per cu. ft, in thicknesses of 1, 1½ and 2 in, but other densities can also be obtained. Texlite is manufactured in sheet form, but the Hairlok Company undertake to cut and fabricate to individual requirements.

Xetal Products Limited, Speke Hall Road, Liverpool.

Hairlok Company Limited, Kathie Road, Bedford.



Weather Resistant Hardboard

From South Africa comes a hardboard which resists weathering without painting. It's called Duranite, and is little different in price from existing hardboards—roughly 1*s* per sq. ft at ¼ in thickness. This is what Wood Fibre Wallboard Company say about the product—they're the people who import it into the United Kingdom.

In industry, Duranite is a blessing to works managers, since its smooth hard surface is extremely resistant to abrasion. It has been used for factory working surfaces and heavy-duty flooring (laid over a concrete floor it eliminates the dust problem). The hardboard is excellent for store room shelving, the thickest board of the range, $\frac{1}{16}$ in, being especially suitable for this purpose. Other possible applications are templates and jigs, since the low moisture absorption of Duranite leads to good dimensional stability. Duranite can also be used in such items of original equipment as paint spray booths, switchboard panels and cooling towers.

Water absorption in 24 hours is 7 per cent on the ¼ in thick material—but this does not necessarily mean that the material loses strength. For wood fibre products, this figure is low. When used for concrete formwork it is said to produce a finish which is almost glossy, and its extremely hard smooth surface shows up well in this application. Deflection and span charts are obtainable on request, but Duranite is much stiffer than ordinary hardboards. Tensile strength is about 4,500 lb per sq. in and roughly three times this figure in compression.

Wood Fibre Wallboard Company Limited, 8 City Road, Finsbury Square, London, EC1.

Aluminium Alloy for Shipbuilding

Alcan Industries have put on the market an improved aluminium-magnesium alloy, Noral D54S, which is now offered as a standard material for both plates and sections for structural use to the requirements of Lloyd's Register of Shipping.

The minimum mechanical properties laid down by Lloyd's Register for aluminium structural alloys are a 0·1 per cent proof stress of 8 tons per sq. in, an ultimate tensile strength of 17 tons per sq. in and an elongation of 12 per cent on a 2 in gauge length. While these are readily attained by plate supplied to the BS 1477 NP5/6 specification, it has been necessary in the past to supply extruded sections to the BS 1476 NE6 specification in order to guarantee these properties. Noral D54S, with a nominal composition of 4·5 Mg-0·75 Mn-0·12 Cr-aluminium, will meet Lloyd's requirements both in the plate and extruded form. This applies in the annealed (O) condition as well as the manufactured (M) condition, leading to the further advantage that the properties after welding do not fall below the minimum properties specified for the material as supplied.

Noral D54S, which is generally similar to the American alloy AA5083, falls within the range of chemical composition covered by the NP5/6 plate specification, but is not yet covered by a British Standard for extruded sections.

Alcan Industries Limited, Banbury, Oxon.

Sisal Reinforced Plastic Dough

Dough moulding compounds are not strictly of immediate interest to engineers as they need heated moulds to form them and demand quite a little expertise. In other words they are materials which are worth bearing in mind when approaching a plastics moulder. But do get him to consider them for your mouldings. Mechanical properties of recent polyester dough moulding compounds are very attractive—especially in impact resistance.

The latest material put on the market should be attractive because of low cost, since it uses sisal fibres for reinforcement instead of glass fibres, which are incorporated in several other existing dough moulding compounds. It is made by Scott Bader under the name of Alpon 5. Note that if the pressing (or moulding) cycles were only fractions of a second, these preimpregnated materials would almost certainly compete with sheet metals for such items as car bodies. For plastic moulding materials, moulding cycles are undoubtedly short—certainly more so than with phenolic, melamine and alkyd compounds—but there is a long way to go yet. Moulding temperatures range from 115 to 155° C, with the optimum around 140° C. At this temperature, most sections up to ⅛ in can be cured in 30 sec but sections up to ¼ should be given a moulding time of 1 min at this temperature. Sections below $\frac{1}{16}$ in are not recommended.

With a specific gravity of about 2·0 gm per cc, impact strength is quite attractive at 4 to 6 ft-lb per in notch (Izod), but tensile strength at 2,000 to 6,000 lb per sq. in is more comparable with thermoplastic materials and is rather disappointing.

Scott Bader and Company Limited, Wollaston, Wellingborough, Northants.

Aluminium Faced Plastic Laminate

A large order of over 11,000 sq. ft of aluminium faced Warerite was supplied to Vickers-Armstrongs yard for installing in the Dreadnought, Britain's nuclear submarine. The material was made by Bakelite and consists of decorative laminated plastic bonded to an aluminium core—of 6, 8 and 10 gauge. It is being used for false bulkheads or panelling for steel bulkheads. The makers comment that it is very easy to clean, and is impermeable, splinter-proof and of great strength.

Bakelite Limited, 12-18 Grosvenor Gardens, London, SW1.

Double Sided Tape

Not much need be said about a new self-adhesive tape made by Evode except that it will be rather fun trying to avoid getting all gummed up—for it sticks both sides. Here then is an alternative to sheet adhesives (which normally entail both heat and pressure for curing) and to ordinary adhesives for flat surfaces. Twinstik, as it is called, comes in widths up to 12 in.

Evode Limited, 82 Victoria Street, London, SW1.

Anode Hooks in Titanium

Over and above its well established use for steam heating coils, ICI titanium is now making another important contribution to efficient and economic nickel plating—provision of non-consumable hooks for supporting nickel anodes.

The cost of anode hooks represents quite a sizeable factor in the economics of nickel plating. Their weight—between 4 and 8 oz—is added in with that of the anode, so that they are paid for at virgin metal prices. Once used, they cannot be relied on for further satisfactory service, and the most the user can hope for is to recover the scrap value of the metal. The difference between buying and selling price corresponds to a loss of at least 1*s* a hook.

This, however, is not the only disadvantage of using nickel hooks. The plating solution which dissolves the anode will naturally have a similar effect on a hook of the same metal. For this reason, some form of protective sheathing of the hook is necessary. In addition, it is usual to work with the hook, and often the top inch or so of the anode too, above the surface of the solution. This not only presents technical disadvantages; it also means that the anode is incompletely used.

Hooks made of titanium are so impervious to attack by nickel plating solutions that they can be used as permanent fixtures—they are screwed into the anode in the normal way and transferred from each finished anode to the next one. Titanium hooks installed early in 1958 are still in service. Apart from wear on the thread, which does not affect performance, they are in perfect condition and are expected to last at least as long again.

Titanium is completely resistant to all commonly used dull and bright-nickel plating solutions. Consequently, the hook can be taken right down into the solution, and the whole surface of the anode is in contact with the plating solution.

Laboratory tests over many months by a manufacturer of nickel anodes show that there is no preferential dissolution of the nickel near the thread. This confirms the experience of platers, who find that fully immersed anodes wear more evenly and can be used more completely. In practice, therefore, the reduction in anode cost is considerably more than 1*s* per operation.

Imperial Chemical Industries Limited, Millbank, London, SW1.

New Formulation for Joint Breaking

"We do not claim that Pitan Joint Breaker will break the joint on what has been allowed to become, through exposure or neglect, a rust-locked coupling." But read this: In one recorded instance the threaded access boss on a heating installation radiator, fixed 12 years ago and in constant use since, utterly defied the efforts of a burly engineer, armed with a 24 in handled "stillson" pipe wrench, lump hammer and chisels, but it succumbed to a five minute application of a tablespoonful of Pitan joint breaker. Or again: Before the close of the day another boss on the same installation was found to be more stubborn—the same tools were used; the boss became cold-chiselled away to such an extent that the wrench could not grip; Pitan joint breaker was applied—but to no avail. More liquid was again applied before leaving that day. Next morning the boss was unscrewed with a hand tool.

The attraction of this new joint breaking liquid, made by Allweather Paints, is that it will attack and soften paints and sealing compounds. Thus it is complementary to penetrating oils and rust-removing liquids which can be used on appropriate occasions for loosening threads and unions. In action it emulsifies with the compounds quite harmlessly so that after a wipe, threads can be reused. If the joint is not recessed to allow it to be submerged, a simple moat can be formed around with the aid of plasticine, clay or even adhesive tape.

Allweather Paints Limited, 36 Great Queen Street, London, WC2.

Dowty Seals

We wish to correct any misleading impression which may have been conveyed by the note "Getting to Know Viton Rubber" on page 635 of our issue of 11 November, 1960.

We had no intention of detracting from the excellent qualities of Dowty seals. We quoted that make of seal because we recognise it to be well-known and outstanding among components of this type.

We deeply regret any ambiguity in the note and we sincerely apologise to Dowty Seals Limited.

Plain Words

By Capricorn

RECENTLY at a meeting of the Textile Institute in Liverpool one of its officials remarked that the motor-car industry should cut itself down to size just as the cotton industry had done—and look what cutting down had done for cotton? In one sense the remark was a splendid comment. It showed a renewed spirit of fight in the cotton industry. From another point of view, the attitude behind the remark is highly dangerous. No economy ever expanded by cutting down, even if the French language is invoked to justify it by saying it is all a question of *receuiller pour mieux sauter*.

The virtue of amelioration through suffering finds exponents it would seem in industry as well as in private life. Likewise the virtue of the reformed rake has a vehemence which the innocent can rarely muster. I have seen many new substitutes for cotton—not all of them successful—but I have yet to see a substitute for the motor-car. (I am ignoring the City types who weave their way through the traffic jams astride a motor-scooter, with black bowler and rolled umbrella.)

One cannot blame the cotton industry for its faintly cock-a-hoop attitude. A few years ago the argument was fashionable that this country should cut down its old industries, like cotton textiles, and rely for the export drive on the engineering industries. We were all to go soaring upwards to greater prosperity on the wings of the new airliners. It was a good, readable line of thought for a responsible Sunday newspaper but it did no great service to the engineering industries. There is no doubt that the engineering industries are the country's big export earners. It is a position to be proud of, but it is also one of great responsibility. No well trained performer dares to make the odds against success bigger by stopping in the middle suddenly and saying "Look, no hands!" The engineering industries, like the economy as a whole, dare not put all their eggs in one, or even a few, baskets. In order to step up the export drive they need the greatest diversification of effort possible consonant with an efficient division of labour. There will always be swings and round-abouts to take into account.

The cotton industry cut itself down because a great deal of its plant was obsolete and the taxpayer is helping out with the scrapping scheme. The motor-car industry is not overtroubled with the first and it is some way off needing the help of the latter. However, when the blue-eyed boy gets into trouble those who have had to endure public lectures about their shortcomings can be forgiven if they get a dig in.

The country needs an efficient cotton industry and efficient engineering industries whatever their size. It needs the diversification which both the others can offer. It is good that cotton has come back. It is still the second largest industry in Lancashire—after engineering.

Letters to the Editor

A British Atomic Forum

SIR, It is gratifying to read Mr. A. J. H. Dove's letter (ENGNG., 16 Dec. '60, p. 816), in connection with my article on "Britain and the European Atomic Forum" (28 Oct., p. 571).

Such responsible reaction as that of the Federation of British Industries technical director encourages me to report the pleasant impression I brought back from a recent visit to the Euratom headquarters in Brussels, where I met many young atomic engineers and industrial economists working earnestly towards the solution of the many problems that confront the Six in the field of nuclear energy. Relations between Euratom officials and their colleagues of the United Kingdom Atomic Energy Authority are excellent and the outstanding British achievements, both in science and technology, are fully acknowledged; no ground could be more fertile for a policy of cooperation at the highest level, implying a close association to Euratom by the United Kingdom.

While decisions in this direction are delayed by complex political difficulties, a prompt association to Foratom by a British Forum to be formed on the lines indicated by my article and by the letter of the FBI's technical director would be the next best step to secure that any advantage gained so far by the British atomic industry is not dwarfed by undue delay, through the results of the earnest effort which is being produced in Europe under the benevolent umbrella of American techniques and finance.

There need be no fear of technicians from this side of the Channel being distracted from their work more than it is necessary to maintain the British industrial prestige on the Continent, where the immediate expectations for British exports of nuclear goods and know-how lie. The universities, the professional and trade associations, lawyers, bankers, insurance companies, consulting engineers, technical writers and all the individuals who are interested in the future of atomic industry will assist in the working of the Forum. A powerful support is bound to come from the Commonwealth, where the bulk of the known uranium reserves of the free world are located; waiting for further industrial progress in the uses of the atomic energy to materialise throughout the world.

I understand that a Canadian Nuclear Association has been formed recently in Toronto, with the object of providing a Forum on lines similar to the European ones.

Yours faithfully,
ALDO CASSUTO.

Wembley, Middlesex.
17 December, 1960.

Experts in Court

SIR, I should like to add a few comments to Mr. F. H. B. Layfield's article entitled "Expert in the Witness Box" (ENGNG., 9 Dec. '60, p. 790).

First of all, it should be remembered that the commonest actions involving experts are for negligence and breach of statutory duty arising out of injuries to employees by machinery in factories. Also common are road accidents due to defects in vehicles or their loading. In such cases, the Courts usually sit without a jury and the Judges are very familiar with factories and motor traffic.

Secondly, the expert witness should try to prepare drawings, plans and photographs to explain his evidence.

Thirdly, the expert witness must remember that the other side will almost certainly call their own expert witness(es), and he must be prepared to answer questions in cross examination on the other side's version.

Fourthly, the expert witness will be taken through his evidence by counsel, who will usually use a copy of the expert's report for this purpose. He may also have a discussion with counsel (an exception to the ordinary rule which precludes counsel from talking the case over with witnesses).

Above all, however, the expert witness is there to give the facts of his examination of the machinery in question and his opinion as an expert on the functioning of this equipment.

He must be very careful not to become too partisan or he will lose the confidence of the Court; he must never argue the legal merits of the case for that is the duty of counsel; he must never express opinions on the merits, for example, whether the matter in issue is negligence or breach of statutory duty, for that is for the Judge alone.

I well remember an engineer, much patronised by certain trade unions, who always produced ridiculously over-simplified drawings (including one showing a spade) and who, in his report, argued the points of negligence and statutory duty and finally gave judgment. He needed firm handling by his own counsel, but in cross examination was frequently a serious liability to his own side.

Yours faithfully,
R. M. A. BRAINE,
Managing Director.

Conforex Limited,
London, EC3.
14 December, 1960.

University Research Reactors

SIR, I have read with interest the excellent articles on university research reactors (ENGNG., 28 Oct. '60, p. 579 and 4 Nov. '60, p. 611).

Although the two articles dealt with reactor makers trying to enter the British university market, it is a pity that one very successful reactor type on the world market has been overlooked; that is, Atomics International's homogeneous solution-type research reactor. Since 1952, the company has built over 15 of these units. They have been placed in operation at various nuclear centres in the United States and abroad. Another 50 kW solution-type medical reactor is being installed at the Walter Reed Army Medical Center in Washington, DC.

The large negative coefficients of temperature and void formation of solution-type reactors provide a high degree of safety, which has permitted their installation in heavily-populated areas.

For use in nuclear research and training programmes, Atomics International manufactures the 10 watt L-77, 1,500 watt L-55, and the 50 kW L-54. These reactors use uranyl sulphate in solution and are designed with small cores and low critical masses, resulting in high neutron fluxes per unit power. To provide irradiation facilities at points of highest neutron flux, radial-beam tubes are placed around the core and through-tubes inside the core. In addition, fission gases in the recombiner are used as a source of almost neutron-free gamma radiation.

Atomics International also manufactures a Solution Type Pulse Reactor (STPR), and has operated the first reactor of this type (the 50 kW KEWB) for the United States Atomic Energy Commission since mid-1956. This reactor has attained a peak thermal power of over 2,300 MW.

The L-77 is a valuable research tool for studying the effects of neutron and gamma radiation on chemical and biological materials, and as a source of short-lived isotopes; and for demonstrating fundamentals in nuclear physics and reactor engineering. The entire core-shield assembly is contained in an outer shield tank 8 ft in diameter and 7 ft high. It can be shipped fully assembled in two boxes containing the console and the reactor assembly. The maximum thermal flux is 3×10^8 n/cm². sec. With extra shielding the rating may be increased to 100 watts. Four reactors of this type have been constructed—two being at universities.

There are two L-55 reactors in operation. The extra power and flux ($4{\cdot}5 \times 10^{10}$ n/cm². sec.) over the L-77 gives it greater versatility, and with additional shielding, the rating may be increased to 5,000 watts.

The L-54 is primarily a research reactor with a high thermal neutron flux of $1 \cdot 5 \times 10^{13}$ n/cm². sec. which is valuable for studies in basic physics and in medical and biological research. The reactor can also be used for radioisotope production and for exponential and danger coefficient experiments. A variety of experimental facilities are provided in horizontal and vertical thermal columns, 14 exposure tubes, and a unique sub-pile gamma irradiation facility. The L-54 is an excellent training device for advanced nuclear physics and engineering studies. There are six now in operation, three of them in Europe.

The STPR is the safest pulse reactor that present technology can create. The inherent safety characteristics of the STPR, and homogeneous research reactors in general, have been demonstrated by operation of the KEWB (Kinetic Experiment Water Boiler) reactor at Atomics International's field laboratory. It will produce peak power levels up to 2,300 MW, delivering 90 per cent of the energy of such a power surge in 0·005 seconds.

Very truly yours,
HENRI POLAK,
Vice-President.

Atomics International Division,
North American Aviation S.A.,
Geneva, Switzerland.
29 November, 1960.

Events in Advance

Finding More Professional Engineers

GOVERNMENT reports on engineering and scientific manpower, issued in 1956 and 1959, examined in some detail the supply of qualified engineers and the demands for their services. Forecasts were made in the reports regarding the probable position in ten years' time, on the basis of industry's estimates of its future requirements.

The conclusion reached was that engineers in sufficient numbers were unlikely to be found within that period. It is, therefore, of the utmost importance to the engineering profession and the country that industry should derive the maximum benefit from the supply of professional engineers now available.

With the object of providing a means for the review and discussion of this topic and its implications, the Engineers' Guild have organised a one-day conference on "The Professional Engineer: His Employment and Development," to take place at the Connaught Rooms, Great Queen Street, London, WC2, on 22 March, 1961. The event is intended to provide a forum for managers, personnel officers and professional engineers generally. The fee payable will be four guineas for members of the Guild and five guineas for non-members.

Sir Hugh Beaver, K.B.E., M.I.C.E., the President of the Guild, will be the chairman of the conference. There will be three set discussions. The first, on "The Engineer and the Technician," will be opened by Mr. D. J. Mann, a director and head of the personnel division of Unilever Limited. The opening speaker at the second, on "The Engineer in Management," will be Mr. A. R. Cooper, M.Sc., M.I.E.E., member for operations and personnel of the Central Electricity Generating Board. The last of the set discussions, on "The Engineer in Society," will be introduced by Viscount Chandos, chairman of Associated Electrical Industries Limited.

Synopses of the addresses referred to and additional information regarding the conference may be obtained from Mr. J. G. Orr, secretary, the Engineers' Guild, 201 High Holborn, London, WC1, or by telephoning HOLborn 1057.

American Symposium on Temperature Measurement

TECHNICAL details have now been completed for a comprehensive meeting in the United States on the wide field of temperature measurement and control. Some two hundred papers are expected to be presented covering temperature measurements of all kinds, from absolute zero to 10,000,000° K, and ranging from the temperature of the human body to that of the sun.

Temperature ranks as one of the most important of the physical qualities, and its measurement and understanding have provided some of the most challenging problems to be encountered in experimental and theoretical physics. Papers have been arranged from American universities and from government, military, and industrial research laboratories in the United States, as well as from research centres in Great Britain, Australia, Canada, Germany, the Netherlands and Russia.

Indeed, a great many sections of the physical, biological and medical sciences will be brought within the sphere of the symposium in one way or another. To be known as the "Symposium on Temperature: Its Measurement and Control in Science and Industry," the conference is being sponsored by the American Institute of Physics, the Instrument Society of America, and the National Bureau of Standards. It will be held at Columbus, Ohio, from 27 March to 31 March, 1961, and will be organised in no fewer than 16 sections.

Among these sections will be those devoted to such topics as basic concepts, temperature scales, thermocouples, resistance thermometers, gas thermometers, pyrometry, automatic methods, measurement in dynamic systems, special sources of temperature, cryogenics, plasmas, and temperature measurement in geophysics, in astrophysics and in medicine and biology.

Three international symposia have already been held in the United States to permit the exchange of information between the various groups of scientists who work with extreme temperatures and precision temperature measurement. The first of the series took place in Chicago in 1919 and the second was held in New York in 1939. The third meeting, in 1954, dealt with fundamental concepts and summarised the developments which had taken place since the conference in 1939. Proceedings of these conferences have been published by the Rheinhold Publishing Company of New York.

Further information regarding these events may be obtained from the Instrument Society of America, 313 Sixth Avenue, Pittsburg 22, Pennsylvania, USA.

A New Name for the Physical Society Exhibition

IN VIEW of the recent amalgamation between the Institute of Physics and the Physical Society, it has been decided that the Physical Society Exhibition of Scientific Instruments and Apparatus shall be known in future as the Annual Exhibition of the Institute of Physics and the Physical Society.

As has been the case during recent years, the coming annual exhibition, to be held from Monday, 16 January, to Friday, 20 January, will take place at the Royal Horticultural Society's old and new halls, Vincent Square and Greycoat Street, London, SW1. On the Monday, the exhibition will be opened only to the Press and to members of the Institute of Physics and the Physical Society. On the remaining four days, the event will open at 10 a.m., closing at 9 p.m. on the Tuesday, at 7 p.m. on the Wednesday and Thursday, and at 1 p.m. on the Friday.

The exhibits to be shown will range from research apparatus for the investigation of newly discovered scientific principles to manufactured instruments in which such principles are applied, and among the many fields being covered are electronics, computing equipment, optics, mechanics, nuclear physics, testing machines and measuring devices, the science of colour, and the study of a wide variety of materials.

It has been arranged that three demonstration-lectures shall be given during the course of the exhibition. The first, by Mr. F. S. Burt, of the Admiralty Research Laboratory, will be entitled "Hydrodynamic Research" and will be delivered on 17 January. The second, by Dr. G. E. R. Deacon, of the National Institute of Oceanography, will be on "The Physics of the Oceans," and will be delivered on 18 January. The last of the series, on "Some Physical Problems in Travelling at Supersonic Speed," will be delivered by Dr. F. P. Bowden, of the Laboratory for the Physics and Chemistry of Solids of the University of Cambridge, on 19 January.

While all the arrangements for the coming exhibition have been dealt with from 1 Lowther Gardens, London, SW7, applications for tickets and requests for information, should be sent to the new organisation's other address, at 47 Belgrave Square, London, SW1.

Gifts and Fancy Goods at Blackpool

TRADE buyers from many countries, as well as the general public, are likely to be attracted in considerable numbers into visiting the exciting exhibition of fancy goods at Blackpool in a few weeks' time.

The organisers, Trade Promotion Services Limited, consider that the collection of gifts and fancy goods then to be placed on show will be one of the most extensive ever to be assembled. Many new and unusual articles will be on show for the first time. There will be an abundant display of goods in precious metals, copper, brass, leather, wood, china and glass. Items shown will include articles for personal use and for the home, and will achieve a high standard of craftsmanship.

The exhibition, known as the Gifts and Fancy Goods Fair, is the twelfth of the series and will be held at Blackpool from 30 January to 3 February. Further information may be obtained from the organiser, St. Dunstan's House, Carey Lane, London, EC2, or by telephoning MONarch 0871.

Exhibitions and Conferences

Society of Automotive Engineers, National Aeronautics Meeting.—Tues., 4 April, to Fri., 7 April, 1961, at the Commodore Hotel, New York. Organised by the Society of Automotive Engineers, 485 Lexington Avenue, New York 17, USA.

Electrical Contacts, Symposium.—Wed., 5 April, to Fri., 7 April, 1961, at Brunel College of Technology, London. Organised by the Institute of Physics and the Physical Society, 47 Belgrave Square, London, SW7 (Tel. BELgravia 6111), in collaboration with the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2. Tel. COVent Garden 1871.

Industrial Accident Prevention Association, Annual Convention and Exhibition.—Mon. and Tues., 10 and 11 April, 1961, at the Royal York Hotel, Toronto. Apply to the Public Service Department, Industrial Accident Prevention Association, 90 Harbour Street, Toronto 1, Ontario, Canada.

Metallic Corrosion, First International Congress on.—Mon., 10 April, to Sat., 15 April, 1961, in the Imperial College of Science and Technology, South Kensington, London, SW7. Apply to Lieut. Col. F. J. Griffin, hon. secretary of the congress, at 14 Belgrave Square, London, SW1. Tel. BELgravia 3681.

Commonwealth Mining and Metallurgical Congress, Seventh.—Four weeks from Mon., 10 April, to Sat., 6 May, 1961, will be spent in Union of South Africa; and two weeks, from Sun., 7 May, to Sun., 21 May, 1961, in Northern and Southern Rhodesia. Apply to the congress manager, Seventh Commonwealth Congress, PO Box 809, Johannesburg, South Africa.

Refrigeration and Air-Conditioning Exhibition, Second.—Tues., 11 April, to Fri., 14 April, 1961, at Earl's Court, London, SW5. Organised by Technical Productions (London) Ltd., 11A Gloucester Road, London, SW7. (Tel. KNIghtsbridge 2945). In addition to the exhibition, there will be a **Refrigeration Convention,** divided into technical and commercial sections. Apply to Mr. Patrick Smyth, 1 Crane Court, Fleet Street, London, EC4. Tel. FLEet Street, 0197.

Chemical Society, Anniversary Meetings.—Tues., 11 April, to Fri., 14 April, 1961, in Liverpool. Will be divided between two sections meeting simultaneously. Offices of the Society: Burlington House, Piccadilly, London, W1. Tel. REGent 0675

Sugar Exhibition, International.—Tues., 11 April, to Wed., 19 April, 1961, in Amsterdam. Organised by the Netherlands Association of Confectionery Manufacturers, 380 Marnixstraat, Amsterdam.

Fabrics Festival, German.—Wed., 12 April, to Fri., 14 April, 1961, in Berlin. Organised by the Arbeitsgemeinschaft Deutsche Kunststoff-Industrie, 21 Karlstrasse, Frankfurt-on-Main 9, Germany.

Milan International Samples Fair, 39th.—Wed., 12 April, to Thurs., 27 April, 1961, in Milan. In the United Kingdom, applications should be made to Dr. V. Schiazzano, 31 Old Burlington Street, London, W1. Tel. REGent 2411.

Swiss Industries Fair, 45th.—Sat., 15 April, to Tues., 25 April, 1961, in Basle. In the United Kingdom, applications should be made to the Swiss Embassy, 18 Montagu Place, Bryanston Square, London, W1. Tel. PADdington 0701.

Fluid Sealing, International Meeting on.—Mon., 17 April, to Wed., 19 April, 1961, at Grosvenor Hall, Ashford, Kent. Registration fee: 3 guineas. Set of papers: 3 guineas. Accommodation: about £6. Organised by the British Hydromechanics Research Association, South Road, Temple Fields, Harlow, Essex. Tel. Harlow 24366.

Shoe Trades Exhibition.—Mon., 17 April, to Fri., 21 April, 1961, at Granby Halls, Leicester. Organised by The Shoe and Leather Record, 133-135 Oxford Street, London, W1. Tel. GERrard 7992.

Tokyo International Trade Fair, Fourth.—Mon., 17 April, to Sun., 7 May, 1961, in Tokyo. Further information obtainable from the Tokyo International Trade Fair Commission, c/o the Economic Bureau, Tokyo Municipal Government, Marunouchi 3-chome, Chiyoda-Ku, Tokyo, Japan.

Engineering, Marine, Welding and Nuclear Energy Exhibition.—Thurs., 20 April, to Thurs., 4 May, 1961, at Olympia, London, W14. Organised by F. W. Bridges and Sons, Ltd., Grand Buildings, Trafalgar Square, London, WC2. Tel. WHItehall 0568.

Knitting Arts Exhibition, 45th.—Mon., 24 April, to Fri., 28 April, 1961, at the Convention Hall, Atlantic City, New Jersey, USA. Includes the exhibition of textile machinery. Apply to Exposition Management, Robert T. Kenworthy, Inc., 10 East 40th Street, New York 16.

Meetings and Papers

British Institution of Radio Engineers

LONDON
"Automatic Techniques in Civil Air-Line Communications Systems," by W. E. Brunt. Radar Group. London School of Hygiene and Tropical Medicine, Keppel Street, WC1. Wed., 4 Jan., 4.30 p.m.*

NEWCASTLE UPON TYNE
"Applications of Photomultipliers in Industry and Research," by J. Hambleton. North Eastern Section. Neville Hall, Westgate Road, Newcastle upon Tyne. Wed., 11 Jan., 6 p.m.

Chemical Society

BRISTOL
"The Analysis of Plastics," by Dr. J. Haslam. Bristol Branch. Department of Chemistry, The University, Bristol. Thurs., 12 Jan., 6.30 p.m.

Combustion Engineering Association

SHEFFIELD
"The Problem of Grit Emission": Discussion, to be introduced by J. W. Batey. Northern Region. Grand Hotel, Sheffield. Tues., 10 Jan., 2.30 p.m.

Illuminating Engineering Society

BIRMINGHAM
Display of Lighting Fittings. Birmingham Centre. Y.M.C.A., Snow Hill, Birmingham. Mon., 2 Jan., 6 p.m.

NOTTINGHAM
"Lighting Effect on Dyes," by W. L. Lead. Nottingham Centre. Electricity Centre, Carrington Street, Nottingham. Thurs., 5 Jan., 6 p.m.

Institute of Metal Finishing

LONDON
Annual Dinner. Café Royal, Regent Street, W1. Sat., 14 Jan., 6.30 p.m. Tickets, price £1 17s 6d each, obtainable from S. W. Baier, 9e Cleveland Road, W13.

Institute of Metals

LONDON
"Metallurgy in Electronics," by Dr. J. E. Hughes. London Local Section. Thurs., 5 Jan., 6.30 p.m.*

OXFORD
"Meteorites," by Dr. H. J. Axon. Oxford Local Section. Cadena Café, Cornmarket Street, Oxford. Tues., 3 Jan., 7.15 p.m.*

Institute of Petroleum

LONDON
"Pre-Flame Reactions in Diesel Engines. Part V.—A Study of Temperature, Pressure and Ignition Delay," by Dr. F. H. Garner, Dr. Frank Morton and J. B. Saunby. Wed., 4 Jan., 5.30 p.m.*

Institute of Refrigeration

LONDON
"The Use of Two-Stage Freezing Procedures for Eviscerated Chicken," by Dr. R. Gane and Dr. D. H. Shrimpton. Institute of Marine Engineers, 76 Mark Lane, EC3. Thurs., 5 Jan., 5.30 p.m.*

Institute of Road Transport Engineers

EXETER
"Servicing of Electrical Equipment," by J. H. Stoneman. South Western Group. Headquarters of the Exeter City Fire Brigade, Exeter. Thurs., 5 Jan., 7.30 p.m.

Institution of Civil Engineers

LONDON
"The Loading of Light Railway Tracks," by J. M. Kesson. Tues., 10 Jan., 5.30 p.m.*

Institution of Electrical Engineers

BIRMINGHAM
"Broadening University Courses": Discussion to be opened by Dr. H. E. M. Barlow. South Midland Centre. James Watt Memorial Institute, Great Charles Street, Birmingham 3. Mon., 2 Jan., 6.30 p.m.*

EDINBURGH
"Protection of Electrical Systems," by H. G. Bell. Second Hunter Memorial Lecture. South East Scotland Subcentre, Carlton Hotel, North Bridge, Edinburgh. Tues., 10 Jan., 7 p.m.

LEEDS
"Water-Turbine-Driven Induction Generators," by C. L. C. Allan. North Midland Centre. Leeds and County Conservative Club, South Parade, Leeds 1. Tues., 3 Jan., 6.30 p.m.*

MANCHESTER
"Radio Communication in the Power Industry," by E. H. Cox and R. E. Martin. North Western Centre. Engineers' Club, Albert Square, Manchester. Tues., 10 Jan., 6.15 p.m.

NEWCASTLE UPON TYNE
"The Application of Electronics to the Electricity Supply Industry," by Dr. J. S. Forrest. Third Hunter Memorial Lecture. Neville Hall, Westgate Road, Newcastle upon Tyne. Mon., 9 Jan., 6.15 p.m.*

Institution of Engineers-in-Charge

LONDON
"Modern Uses of Fuel Oil," by G. E. Fenner. Caxton Hall, off Victoria Street, SW1. Wed., 11 Jan., 6.30 p.m.*

Institution of Heating and Ventilating Engineers

LONDON
"Electrostatic Air Filtration," by M. O. Penrose. Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, SW1. Thurs., 12 Jan., 6 p.m.*

BRISTOL
"Mechanical Services in the New Lloyd's Building," by J. R. Kell. South Western Branch. RWA School of Architecture, Bristol. Tues., 3 Jan., 6.30 p.m.

LIVERPOOL
"Experiences in America of Heating and Air-Conditioning Practice," by C. S. K. Benham. Liverpool Branch. Exchange Hotel, Tithebarn Street, Liverpool. Wed., 11 Jan., 6.30 p.m.

NEWCASTLE UPON TYNE
"The Heating and Air Conditioning of Lloyd's New Building, Liverpool," by J. R. Kell. North East Coast Branch. Neville Hall, Westgate Road, Newcastle upon Tyne. Tues., 10 Jan., 6.30 p.m.

Institution of Mechanical Engineers

LONDON
"Lubrication of Automotive Worm Gears," by J. Whittle. Automobile Division. Tues., 10 Jan., 6 p.m.*

ABERDEEN
"Corrosion Fatigue," by Professor A. W. Scott. Scottish Branch. Robert Gordon's Technical College, Aberdeen. Fri., 13 Jan., 7.30 p.m.

BRISTOL
"Design and Construction of the Compressor for the 8 ft by 8 ft High-Speed Wind Tunnel, at the RAE, Bristol," by L. J. Cheshire. Western Branch. Engineering Laboratories, The University, Bristol. Thurs., 12 Jan., 7 p.m.

CHELMSFORD
"Investigation of Radio Sources at Jodrell Bank," by H. P. Palmer. Eastern Branch. Joint Meeting with the Chelmsford Engineering Society. Hoffman's Social Hall, Chelmsford. Thurs., 5 Jan., 7.30 p.m.

GLASGOW
"Corrosion Fatigue," by Professor A. W. Scott. Scottish Branch. Royal College of Science and Technology, Glasgow. Thurs., 12 Jan., 7.30 p.m.

LEEDS
"Direct Conversion of Heat to Electricity," by P. D. Dunn. Yorkshire Branch. The University, Leeds. Thurs., 12 Jan., 6.30 p.m.

LEICESTER
"Vibration of Vertical Milling Machines under Testing and Working Conditions," by Professor S. A. Tobias. East Midlands Branch. College of Technology and Commerce, Leicester. Thurs., 5 Jan., 7.15 p.m.

Institution of Plant Engineers

LONDON
"Recent Developments in Lighting," by H. Hewitt. Royal Society of Arts, John Adam Street, Adelphi, WC2. Tues., 10 Jan., 7 p.m.*

LEICESTER
"River Dove Water Scheme," by Hal. Wallhouse. Leicester Branch. Midland Hotel, Leicester. Wed., 4 Jan., 7.30 p.m.

PETERBOROUGH
"Future Railway Development in Peterborough and District": Discussion. Peterborough Branch. White Lion Hotel, Church Street, Peterborough. Tues., 3 Jan., 7.30 p.m.

SOUTHAMPTON
"My Job": Discussion. Southern Branch. Polygon Hotel, Southampton. Wed., 4 Jan., 7.30 p.m.

Institution of Production Engineers

DONCASTER
"Tracer Control of Machine Tools," by H. C. Town. Doncaster Section. New Technical College, Doncaster. Tues., 10 Jan., 7 p.m.

LIVERPOOL
"Recent Developments in the Soviet Union," by Dr. D. F. Galloway. Liverpool Section. Liverpool International Library, William Brown Street, Liverpool. Wed., 11 Jan., 7.30 p.m.

Institution of Structural Engineers

BRISTOL
"Lift-Slab Design and Construction," by F. R. Benson. Western Counties Branch. University Engineering Laboratories, University Walk, Bristol 8. Fri., 6 Jan., 6 p.m.

NEWCASTLE UPON TYNE
"Value for Money in Building," by E. S. Benson. Northern Counties Branch. Neville Hall, Westgate Road, Newcastle upon Tyne. Wed., 4 Jan., 6.30 p.m.

Junior Institution of Engineers

LONDON
Film Evening. Fri., 6 Jan., 7 p.m.*

SHEFFIELD
"Inspection and Testing by Non-Destructive Techniques," by D. W. Tasker. Sheffield Branch. Livesey Clegg House, 44 Union Street, Sheffield 1. Mon., 9 Jan., 7.30 p.m.

Leeds Metallurgical Society

BRADFORD
"Some Recent Developments in the Welding of Metals," by E. N. Gregory. Bradford Institute of Technology, Bradford. Wed., 4 Jan., 6.30 p.m.*

Newcomen Society

LONDON
"Joshua Gilpin, an American Manufacturer in England and Wales: Part II—1811-1814," by Dr. Harold B. Hancock and Dr. Norman B. Wilkinson. Wed., 4 Jan., 5.30 p.m.

Pipeline Industries Guild

LONDON
"Internal Coating," by J. Rogers. Caxton Hall, off Victoria Street, SW1. Tues., 10 Jan., 6.30 p.m.

Reinforced Concrete Association

MANCHESTER
"The Selection of Plant and Its Consequences in Reinforced-Concrete Construction," by D. Bishop. North Western Branch. College of Technology, Sackville Street, Manchester. Mon., 9 Jan., 6.45 p.m.*

Royal Aeronautical Society

LONDON
"Planning of Missile Acceptance Trials," by J. F. W. Mercer and A. R. Cawthorne. Tues., 3 Jan., 6 p.m. (*Cancelled.*)

Royal Institution of Chartered Surveyors

LONDON
"Fire Precautions in Buildings," by Chief Officer F. W. Delve. Mon., 2 Jan., 5.45 p.m.

Royal United Service Institution

LONDON
"Defence in the Nuclear Age, 1961," by Commander Sir Stephen King-Hall, R.N. retd. Wed., 4 Jan., 3 p.m.

Society of Instrument Technology

LONDON
"The Tallimarker: An Information-Handling Scheme for Processing Lines," by W. L. Marks and D. J. Mayes. Data Processing Section. At British Iron and Steel Research Association, 140 Battersea Park Road, SW11. Wed., 11 Jan., 6 p.m. To be preceded by a visit to the Association's premises earlier on the same day.

FAWLEY
"Electronics and Instrumentation in the Glass Industry," by J. R. Beattie. Fawley Section. Administration Building, Esso Refinery, Fawley. Fri., 6 Jan., 5.30 p.m.

LIVERPOOL
"Load Cells," by J. M. Hook. Liverpool Section. Industrial Development Centre, Manchester and North Western Electricity Board, Liverpool. Thurs., 12 Jan., 7 p.m.

SHEFFIELD
"Instruments and Cherry Blossom: Some Impressions of a Technical Visit to Japan," by W. C. Heselwood. South Yorkshire Section. The University, St. George's Square, Sheffield 1. Wed., 4 Jan., 7 p.m.

South Wales Institute of Engineers

CARDIFF
"Strain Ageing of Mild Steel," by W. J. S. Roberts. Thurs., 12 Jan., 6 p.m.

Television Society

LONDON
"A Wide Range Standards Converter," by E. R. Rout and R. F. Vigurs. Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, WC2. Fri., 13 Jan., 7 p.m.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. An asterisk (*) is placed where it is understood that refreshments are available prior to the time stated.

British Institution of Radio Engineers, 9 Beford Square, London, WC1. (MUSeum 1901)
Chemical Society, Burlington House, Piccadilly, London, W1. (REGent 0675)
Combustion Engineering Association, 70 Jermyn Street, St. James's, London, SW1. (WHItehall 5536)
Illuminating Engineering Society, 32 Victoria Street, London, SW1. (ABBey 5215)
Institute of Metal Finishing. Apply to 11A Gloucester Road, London, SW7. (KNIghtsbridge 9181)
Institute of Metals, 17 Belgrave Square, London, SW1. (BELgravia 3291)
Institute of Petroleum, 61 New Cavendish Street, London, W1. (LANgham 3583)
Institute of Refrigeration, New Bridge Street House, New Bridge Street, London, EC4. (CENtral 4694)
Institute of Road Transport Engineers, 1 Cromwell Place, South Kensington, London, SW7. (KENsington 3744)
Institution of Civil Engineers, Great George Street, London, SW1. (WHItehall 4577)
Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2. (COVent Garden 1871)
Institution of Engineers-in-Charge, 13 Grange Close, Edgware, Middlesex. (MILl Hill 3543)
Institution of Heating and Ventilating Engineers, 49 Cadogan Square, London, SW1. (SLOane 3158)
Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London, SW1. (WHItehall 7476)
Institution of Plant Engineers, 2 Grosvenor Gardens, London, SW1. (SLOane 0469)
Institution of Production Engineers, 10 Chesterfield Street, London, W1. (GROsvenor 5254)
Institution of Structural Engineers, 11 Upper Belgrave Street, London, SW1. (SLOane 7128)
Junior Institution of Engineers, Pepys House, 14 Rochester Row, London, SW1. (VICtoria 0786)
Leeds Metallurgical Society. Apply to Dr. P. R. Beeley, The University, Leeds.
Newcomen Society, Science Museum, Exhibition Road, London, SW7. (KENsington 1793)
Pipeline Industries Guild, 7 Iddesleigh House, Caxton Street, London, SW1. (ABBey 6925)
Reinforced Concrete Association, 94-98 Petty France, London, SW1. (ABBey 4504)
Royal Aeronautical Society, 4 Hamilton Place, London, W1. (GROsvenor 3515)
Royal Institution of Chartered Surveyors, 12 Grea George Street, London, SW1. (WHItehall 5322)
Royal United Service Institution, Whitehall, London, SW1. (WHItehall 5854)
Society of Instrument Technology, 20 Queen Anne Street, London, W1. (LANgham 4251)
South Wales Institute of Engineers, Park Place, Cardiff. (Cardiff 23296)
Television Society, 166 Shaftesbury Avenue, London, WC2. (TEMple Bar 3330)

Braking Correlated for Car and Caravan

Road tests on a car-caravan combination, using electronic recording apparatus, demonstrate that braking of the trailer was more effective when a hydraulically damped coupling was fitted.

By Charles Haywood

THE performance of the Beta caravan coupling system and its effect on the braking of a car-caravan combination were the subject of recent investigations by Ferodo Limited. The Beta III, which incorporates a hydraulic damper instead of the more conventional spring loaded unit, is designed and manufactured by B & B Trailers Limited of Leamington Spa.

The caravan used for the tests was a 1958 Cresta Trans-Continental fitted with 8 in diameter Lockheed centre-pull brakes. It was towed by a Standard Vanguard estate car and at other times by an Austin A50. Following some 1,200 miles of very varied road conditions it was found that the average ratio between car and van braking was 2 to 1, and that there was

Fig. 1 Standard Vanguard estate car used by Ferodo to test caravan overrun braking system.

progressive braking with a feeling of safe handling when travelling on crowded roads.

For recording the data a Ferodo designed apparatus known as "SCARAB" was used. SCARAB or "selective cine apparatus recording automotive braking," was designed by Mr. A. D. M. Frood, electronics and instrumentation engineer at Ferodo for use in a Monte Carlo rally car. The instruments are contained in a box measuring 22 in by 13 in by 10 in for ease of transport and the box is compact enough to be carried in the boot of a car.

Included in the equipment are temperature gauges connected by thermocouples to the brake linings, a brake pedal pressure meter, a hydraulic line pressure meter, a decelerometer, speed and distance recorders and counters to record how many times and for how long the brakes on the car and van are applied. The data collected is transmitted to dials set in a panel and the readings are photographed by a cine-camera fitted with a very short focus wide-angle lens. A preselector mechanism enables every single, every third or every fifth brake application to be recorded, or the mechanism may be set to operate at short regular intervals.

A film is only taken of the instrument panel when pressure is applied to the car brakes. The dials are then automatically illuminated and the camera started. With the brake pedal in the "off" position, the panel lights and camera are switched off and a fractional hp motor rewinds the camera for the next shot.

Testing on the road took place during a journey from the Ferodo works to Hawick, the starting point of the National Caravan Rally, during the rally, and in the Peak District. It was possible to record the braking efficiency over more than 1,000 miles of driving which included normal touring conditions, night rallying, and hard going on crowded trunk roads. Comparisons were made with figures obtained on earlier tests when the van was fitted with a standard spring-loaded coupling, and it was then found that the car was doing most of the braking.

The results obtained on the recent tour showed a great variation between the figures for night and daytime driving. Over a distance of 125 miles from Kendal north, including a descent of Shap Fell and a great deal of heavy

Fig. 3 Fitting a load transducer cell to measure the pull on the caravan brakes.

traffic the average speed was 27·8 m.p.h. The car brakes were applied 1·8 times every mile and the van brakes came on 2·12 times or 18 per cent more in the same distance. The average duration of the applications was 2·9 sec per mile for the car and 3·1 sec per mile or 7 per cent more for the van.

On traffic free roads late at night and with the average speed set at 30 m.p.h., SCARAB recorded brake applications of 0·49 per mile for the car and 0·94 per mile or 90 per cent more for the caravan. The duration of the applications was also shorter than it had been during the daylight mileage, but the caravan brakes were in operation 29 per cent more than those on the car. The times were 0·84 sec per mile on the car and 1·09 sec per mile on the van.

The differences between the sets of figures recorded on these two occasions are primarily caused by the vastly different traffic conditions. Although in the daytime the average speed was less than it was at night, the driver obviously had to keep going to maintain his average of 27·8 m.p.h., with consequent harder and more frequent braking. At night on clear roads with easier gradients and fewer bends the driver was able to anticipate braking and slowed the outfit by making use of the gearbox to a much greater extent. This procedure resulted in the braking system of the caravan coming into action more when on the overrun and slowing the two vehicles together.

After the rally during a trial stop down a 1 in 4 gradient with a deceleration of 40 per cent, the pull on the van brake rod shown on the instrument panel was 500 lb, which, for comparison, is greater than a lady motorist driving, say, a Hillman Minx, could apply to her brake pedal in an emergency. Going down a 1 in 14 gradient at 30 m.p.h., however, once the car's brakes were applied the caravan brakes remained lightly on (with a rod pull of 40 to 50 lb) until the car accelerated away from the trailer.

Temperature readings were taken during the rally from the leading shoes of the caravan brakes and the top leading shoes of the car front brakes. It is presumed that the front brakes were chosen in preference to those on the rear axle to avoid any additional heat from the differential. The average readings showed that the caravan brakes were operating at temperatures 40 to 50 per cent higher than those

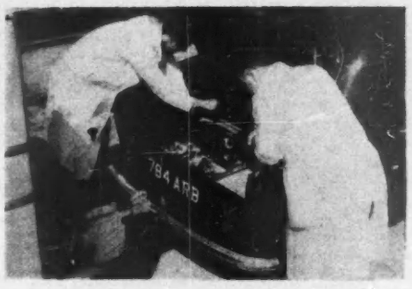


Fig 4 Scarab recording apparatus in the A50 boot and the coupling in position for towing.

on the car, usually in the region of 100 to 120° C.

One wonders what happens when touring in Alpine country in the heat of summer and the braking equipment of the towing car is working to the limit. In these circumstances would the van suffer from brake-fade unknown to the driver? It is imagined that the experienced caravanner would sense the symptoms and act accordingly. The Ferodo tests would seem to indicate that when a caravan braking system is called upon to do a very fair share of the work, as in this case, only very efficient linings should be fitted and the brakes should be properly tested before any extended tour. Some form of scoop might even be fitted under the van to deflect cooling air on to the brake drums.

Another point which emerged as a result of the tests and one which is of interest to the man who covers long distances when touring is the rate of lining wear on the van. Measurements taken showed that the leading shoe liners had worn 0·005 in and the trailing shoe liners 0·0015 in per 1,000 miles. These results compare very favourably with the number of recorded brake applications. Cars in the Ferodo test fleet which are fitted with similar brake equipment on the rear axle give average wear figures of 0·009 in and 0·004 in per 1,000 miles for the leading and trailing shoes.

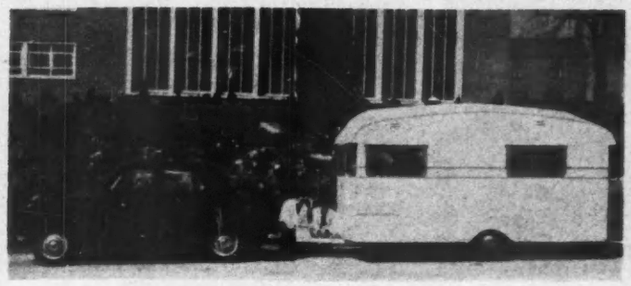


Fig. 2 Austin A50 and caravan fitted with Beta III overrun braking system used in preliminary trials shown outside the Ferodo Research Centre.

Australia Looks to Rising Steel Production

The rapid growth of Australian steel production since the war is a yardstick of her increasing industrialisation. It is a growth significant not only for its sheer volume but also for its technical advance.

By Clive Turnbull

Australia House

IN THE last 20 years Australia has consolidated herself among the Commonwealth countries as the third largest producer of iron and steel with the largest single steel producing group. Only the United Kingdom and Canada are larger producers, the first quite substantially but Canada by a comparatively small amount bearing in mind the difference in population of these two countries—Australia with 10,230,000 people and Canada with 17,000,000.

In consumption per head of steel, the best indicator of intensity of steel usage and of comparative industrialisation, all three countries are very close. Each consumes on an average between 700 and 900 lb of ingot steel (in equivalent form) per head each year. Whereas the United Kingdom and Australia are very largely self-sufficient in steel-making facilities, Canada relies heavily on imports from the nearby steel plants of the United States of America.

The remarkable growth of the Australian iron and steel industry is a reflection of the no less remarkable growth of the Australian secondary production which it supports. The leap forward on all industrial fronts, particularly in the post-war period, has placed extraordinary demands on this basic industry and there is every indication that these demands will continue.

Australia has never been in the position of having a ready steel supply close at hand and, therefore, has had to instal her own facilities to supply local needs. So rapid has been the industrialisation of Australia since 1944 and so rapidly has the population and national income grown, that steel production has been inadequate to meet peak local demands, in spite of the fact that the basic iron and steel producers in Australia have invested £A180,000,000 in the past 15 years. However, the gap is steadily being reduced as a result of the continuing expansion of the industry, and it is expected that Australia will be fully self-sufficient in almost all kinds of steel by the mid-1960's.

Indeed, by that time the nation may also have a permanent exportable surplus of many steel products. Steel demand has been rising in Australia since the war at an annual average rate of more than 6 per cent—the highest rate of expansion to be found anywhere. Endowed with good natural resources, a relatively small but rapidly growing population, and with financial resources which place her among the rich countries of the world, so rapid an advance as a steel user and producer is hardly surprising. When Australia's distance from the main centres of iron and steel production is also taken into account, there is a further incentive to increase home output.

At present rates of expansion and having in mind what is expected of the Australian economy during the 1960's, there may well be a further doubling of steel production and possibly of consumption by 1970. At present Australia produces rather more than 3·5 million ingot tons of steel a year. This is expected to rise to 4 million tons by 1961 and to between 6 and 7 million tons by 1970.

The production of basic iron and steel in Australia is the responsibility of a closely associated group of companies under the central control of the Broken Hill Proprietary Company Limited. "B.H.P." is a public corporation owned by 60,000 shareholders. It is linked through ownership with 16 proprietary companies, the largest of them concerned, like B.H.P. itself, with the production of basic iron and steel. The others handle the further working up of semi-finished steel into finished steel products such as wire, the production of special alloy steels, or servicing functions for the main producing companies. In addition to its own group of companies, B.H.P. is also linked financially, although as a minority shareholder, with the steel tube industry, with the steel container industry and with the aircraft industry.

PRODUCTION ORGANISATION

The iron and steel industry of Australia under B.H.P. is today as efficient technically as any in the world. The company unceasingly pursues a programme of plant modernisation and of expansion. Each year it ploughs back a very large proportion of its earnings into replacement of plant and the addition of new iron and steel-making facilities. In recent years, the company and its subsidiaries have been investing £A25 million a year in capital works.

From a very early time, B.H.P., as an iron and steel producer, became a highly developed and self-reliant company. It pursued vertical integration to the utmost and it also encouraged the establishment of steel using companies in Australia, thus increasing the openings for its own products. At a later stage and particularly during the difficulties which Australian heavy industry encountered in the 1920's and early 1930's, B.H.P. was obliged, in the interest of preserving the outlets for its steel, to take over some of the steel finishing companies which had initially been set up independently. In this way the B.H.P. group of companies came into existence and it was further added to as the years passed.

The Australian iron and steel industry has a valuable inheritance in raw materials. It has also greatly benefitted from the wise choice of location for its iron and steel works. As time has passed, it has become more apparent that the choice of Newcastle and Port Kembla in New South Wales was a farsighted selection.

For the last 30 years, B.H.P. has been able to achieve levels of cost and and selling prices which compare more than favourably with overseas producers. Not even the steep rise in many costs which has gone on in Australia since 1950 has reduced the comparative advantage B.H.P enjoys in the home market and in a number of export markets. During the same 30 years, tariff protection on almost all of the company's products has been unnecessary, since even the duty free landed price in Australia of overseas steel is generally considerably higher than the prices at which B.H.P. is able to sell its products. For these reasons, Australian steel has considerable potential in export markets, but because home demand has risen so rapidly, it is only in some years that Australia has a surplus.

It is not unlikely, however, that during the next decade continuing investment at a high rate in new iron and steel-making facilities will make available sufficient capacity for a permanent export market to be established.

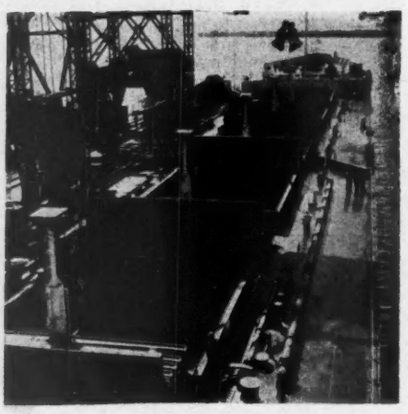
Technologically B.H.P. and its subsidiary companies have kept closely in step with American practice. This has been due as much to the similarity in quality of raw materials as to the association of the Newcastle steelworks in their early days with key personnel brought out from America. Consequently, the industry has relied on the basic open hearth steel furnace as the key unit in steel-making. It has also preferred a few large basic units of plant to a number of small ones. This has been particularly true of the facilities installed during the past 15 years. B.H.P. has been quick to note changes in technology and to adopt them in its own plants.

The 1960's will thus prove to be a decisive decade for the Australian iron and steel industry. It will probably see production climb by 100 per cent, and it will also see the development of a fully integrated steel-making plant at Whyalla in South Australia. Hitherto an ore shipment port, the centre of a blast furnace producing foundry iron and Australia's largest shipbuilding yard, Whyalla is to become Australia's third major steel-making centre by 1970.

Thus, while the Australian population may never in the foreseeable future come to match those of its nearer neighbours in South-East Asia, its industrial output per head will eclipse all of them. On a per capita basis, Australia, without doubt, is destined to become the workshop of South-East Asia.

(Left) Hot metal is fed into a 300 ton open hearth furnace at Australia's largest steelworks at Port Kembla on the New South Wales coast.

(Right) The 19,100 ton "Iron Flinders," used to carry iron ore between Yampi Sound, Western Australia, and Port Kembla steelworks.



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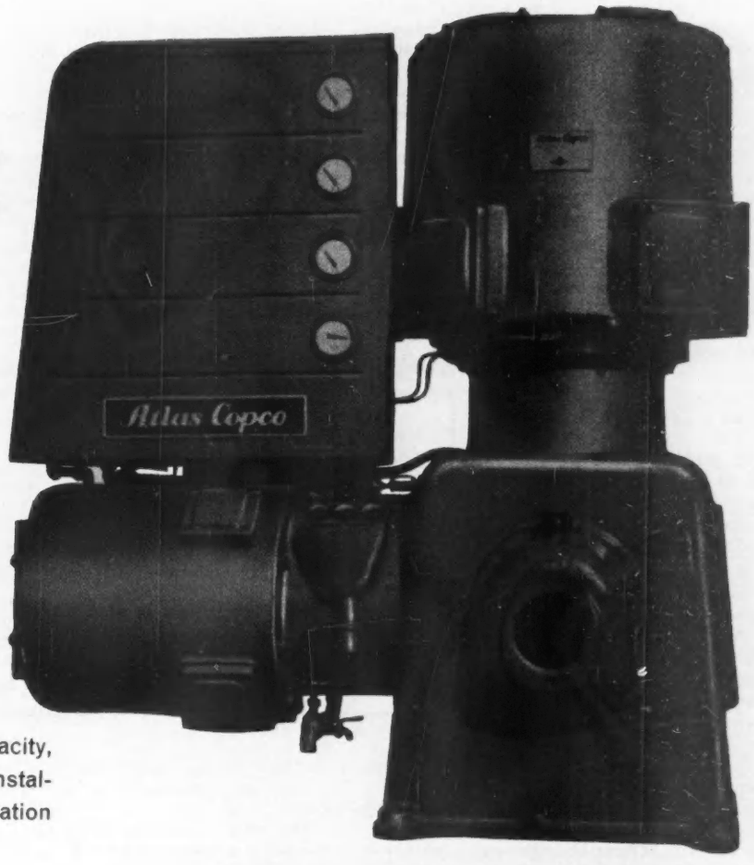

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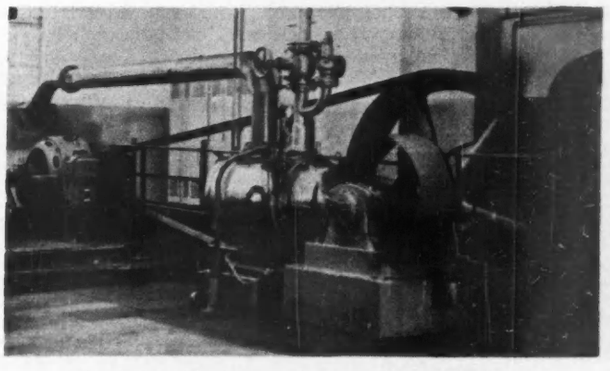

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ENGINEERS' INCOMES—GOING UP?

The 1960 Report by the Engineers' Guild

The incomes of professional engineers are moving upwards—that much is clear from the results of the Guild's latest survey. The median income for all ages has risen by 32 per cent in the last four years and the detailed figures show a comparable increase for all age groups and fields of employment. It is less clear, however, whether the improvement merely reflects what has been happening in other professions and in the country as a whole, or whether the relative economic standing of the engineering profession has significantly changed.

The survey was carried out between April and August, 1960, and is based on earnings during the financial year 1959/60 which ended on 5th April.

Information was sought from a random sample of 4,400 corporate members of the Institutions of Civil, of Mechanical, of Electrical and of Chemical Engineers, and in all 2,727 completed questionnaires were received, with an effective response rate of 67·4%. The results therefore present an accurate picture of the level and distribution of incomes in the engineering profession at the present time. The Table shows the medians and quartiles for all engineers in 1959/60, with figures for 1955/56 given alongside for comparison. The earlier figures did not include members of the Institution of Chemical Engineers, but in view of the relatively small numbers involved, their influence on the 1959/60 figures is slight. Similarly, the latest survey included engineers in Northern Ireland, who were not covered last time, but the numbers are too small to affect the overall results.

The results of the first survey showed the incomes of engineers to be so low as to bear little or no relation to the training and experience required of the professional engineer, or to the responsibilities which he carried. The comparative figures for other professions published a few months later in the Report of the Royal Commission on Doctors' and Dentists' Remuneration confirmed that the relative economic position of engineers was equally unsatisfactory. In such circumstances it would have been remarkable if the last figures had not shown any appreciable improvement, since there was evidence of a general upward movement in incomes at all levels in the community. In addition, the work of the Guild has focussed attention on the importance of the services rendered by the engineering profession, and on the need for this to be reflected in substantially improved levels of salary and career prospects if the quality and quantity of new entrants is to be sufficient to meet the country's needs. This work has undoubtedly begun to take effect, even though it must be maintained and intensified before salaries in the profession can be established at their proper level.

One of the weaknesses of the Royal Commission Report as a source of information about economic conditions in the professions is that its figures were already dated by the time they were published. Yet no survey of similar scope has been undertaken since or is likely in the future. Inevitably, therefore, it is difficult to make reliable comparisons with the results of the latest Guild survey.

PROFESSIONAL ENGINEERS' INCOMES—MEDIANS AND QUARTILES BY AGE

AGE GROUPS	Lower Quartile £s		Median £s		Upper Quartile £s	
	1959/60	1955/56	1959/60	1955/56	1959/60	1955/56
under 35 ..	1145	837	1316	953	1540	1110
35–39 ..	1292	965	1501	1142	1789	1376
40–44 ..	1365	1040	1632	1281	2115	1659
45–54 ..	1419	1150	1778	1484	2474	2000
55–64 ..	1620	1216	2048	1652	2977	2305
All ages	1304	950	1574	1181	2042	1600

Such information as is available, however, suggests that engineers, particularly the younger members of the profession, have substantially improved their relative position in the community during the last four years. There are, however, good reasons for hesitating before accepting any such conclusion. The Royal Commission had prepared for it a list of " career earnings " in the professions, derived from the earnings figures for the different groups and representing the total income over the period age 30–65, which the Commission concluded were "for the purpose of comparing one profession with another the most important years of a man's life to be studied". The range was very wide, varying from £54,000 for architects and £59,000 for engineers up to £105,000 for actuaries and £117,000 for medical consultants. The figure for all National Health Service doctors was £84,000, and the effect of the Commission's recommendations (which have since been accepted) was to increase this figure to £102,000 from January of this year. The comparable career earnings for engineers in 1959/60 is £71,000.

What conclusions then can be drawn from this latest survey? Perhaps the safest is that the profession is in a stage of transition; the demand for young engineers has had a marked effect on incomes at this level and has certainly raised them to a proportionally greater extent than for older engineers in the middle ranks. It seems likely that the spread of incomes is becoming much wider even in the lower age groups; for example, in 1955/56, 57·3% of those in the age group 35–39 earned less than £1,200 and 5·5% earned more than £2,000. In 1959/60, for the same age group, the figures are 13% and 14·9% respectively. There are considerable variations between the earnings of university graduates and non-graduates, and this too is bound to affect the income patterns within the profession as the proportion of graduate entrants increases.

THE ENGINEERS' GUILD 201 HIGH HOLBORN LONDON WC1

I, the undersigned, hereby apply to be accepted as a Member/Associate of Engineers' Guild Ltd., and I agree to be governed by its Constitution and Bye-Laws.

FULL NAME (BLOCK LETTERS) ..... DATE .....

ADDRESS .....

.....

PROFESSIONAL QUALIFICATIONS .....

SIGNATURE .....

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E/1/61

How to obtain further information :

This summary of the report was published in the *Newsletter* of the Engineers' Guild. The full report and tables will be appearing in the January 1961 issue of *The Professional Engineer*, copies of which are sent to every member.

ENGINEERS eligible for membership who complete and return the form will receive a copy immediately on publication without further charge.

EMPLOYERS can obtain copies on request (price 5/- post free) and the Engineers' Guild will be pleased to advise on particular points from the information which it has available.

Human Element

Preventive Maintenance in an Automated Foundry

For dirt and dust and wear and tear there are few places to match an iron foundry. And when £500,000 is spent on some of the most advanced automatic plant in Europe the problem of keeping one step ahead of trouble becomes something of a preoccupation.

At Derby, a young engineer, Tony Cawley, who is works administrator for Qualcast, has worked out and put into practice his own methods of preventive maintenance for the company's automatic plant in their grey iron foundry.

This equipment, from a German manufacturer, is capable of producing 400 tons of castings a week, employing only about 30 men. The castings range in size from about 6 lb up to a maximum around 60 lb. Using what, in effect, amount to production line techniques the automatic foundry circulates 162 pallets, each one taking approximately 30 minutes to make the complete journey.

With production at this pace from a £500,000 machine it follows that minutes spent in avoidable repairs and replacements all add up to a great deal of money lost. The preventive maintenance that Cawley has put across to his fitters with missionary zeal aims at finding and correcting troubles before they lead to breakdowns.

Orders of Priority

The first essential is the system of categories. The fitter on duty, observing the machines and receiving information from the operatives, can list work to be done under three headings. Category A is first priority urgency. Work under this heading is to be done immediately after the particular shift. Category B work can be done at the week-end, and C means that what has to be done can wait until the next major shut down, usually a public holiday.

Behind the four maintenance fitters stands a growing body of collated information on each of the 74 items of machinery, plant and transmissions that make up the automatic foundry. From the cards kept on each machine the fitter can swiftly see the peculiarities he may encounter. A big advantage of this scheme is that when a fitter leaves, his special knowledge of the equipment does not leave with him. A new man joining the maintenance team will inherit much of the acquired knowledge of the work that has already been done.

Timing the Job

Carrying the project a step forward, Cawley is working out for each machine a card describing how particular jobs are to be done, what is to be watched for, and even what tools are to be taken to the job.

In time it will be possible to establish the times that are to be taken over maintenance and routine repair jobs.

The Qualcast firm, best known to the public for their lawn mowers, in fact produce so wide a range of castings for the motor industry that they reckon to have at least one casting in every British car and possibly as many as 14. The materials in their Qualcast castings include the whole range of British Standard Specification BS 1452, grades 10 to 26 inclusive.

In the year 1959-60 the company provided nine-tenths of the total supply of iron castings for brake equipment used by the motor industry.

Qualcast are particularly proud of the fact that in the last ten years, on the ferrous diecast side of their foundry work customers' rejects have been reduced to an average of 0·38 per cent of the total of 30 million castings in the year, a level they believe to be unequalled, against a former average of 1·4 per cent.

BEC and TUC to Meet on Labour Relations

Whatever 1961 is to see in the way of industrial relations it is to start off with cooperation at the highest level.

The British Employers' Confederation and the Trades Union Congress recently met for two hours, discussing what can be done to further the proposal from the Minister of Labour that a joint examination of the causes of labour disputes could be made by "the two sides of industry."

This exploratory talk is to be carried on in a number of meetings, the first of which will be held in January. Evidently what has happened to ease the coming together of the two bodies on this touchy subject is acceptance of the idea that the examination will aim at getting to the roots of the trouble in British industrial relations. It will not simply be used as an opportunity for casting blame for past discontents.

To some extent the views of the principal trade union leaders are much those set out in the TUC's report on strikes and their causes. In this report the TUC calls into question the type of inadequate management which allows rumours to grow through withholding information and which fosters serious trouble by keeping vital questions like redundancy out of joint discussion and procedural agreements.

What is not so clear is what effect high-level talks between the employers federation and the top trade unionists can have at the practical level of factory floor and shop stewards' meetings. The gulf between Congress House and the canteen meeting in the works is immense. It is also not over likely that the more difficult sort of manager is going to embrace more responsible habits of sharing information with his employees simply because the BEC says it is a good thing to be doing.

Building Industry Costs to Go Up £60 Million

The six per cent pay rise and two hours off the basic working week which will come into effect for a million building workers next October, will cost the building industry £60 million a year. Inevitably increases in the cost of house and other building will follow.

The team of negotiators from the National Federation of Building Trade Employers and from the unions had pursued a long course of discussions in which the unions had tried hard to have part of the package deal brought forward. They were hoping to get something more from February onwards.

The employers were strongly conscious of the danger that if a rise in wages and therefore in costs were allowed to take place before the autumn there would be some builders making a loss and others, who took account in their tenders of the increased labour charges, losing contracts.

The reduction to a working week of 42 hours without loss of pay is estimated to mean an extra 3*d* an hour on the rates. On top of this the recent increase in the index of retail prices means that under the agreement on a "sliding scale" related to the cost of living building workers will be receiving an extra ½*d* an hour in the New Year.

Civil Engineering Men Seek 8d an Hour More

While the industry is contemplating the effects of the agreement for building workers, the leaders of some 250,000 workers in civil engineering have decided to ask for 8*d* an hour more on their rates, an increase of almost £1 8*s* 6*d* a week.

Civil engineering workers' wages have been more or less stationary for two years—since in February, 1959, the rates were lifted by a penny an hour under the industry's cost of living agreement.

When the working week was reduced without loss of earnings last February to 42⅔ hours with increases in overtime pay, the employers estimated that this was equal to 1½*d* an hour more on pay rates.

The case the civil engineering workers are to advance in support of their £20 million a year claim will be heard at a meeting next month.

Investigating Ford Labour Relations

A vigorous management, high wages and a mixed group of skilled and semi-skilled men makes for remarkably few dull moments at the Ford Motor Company's Dagenham works. More than 60 stoppages among the men during 1960, including complete stoppages of the car side, testify to a state of affairs which is more than due for a long cool reexamination.

This is what leaders of the 22 unions who have members employed at Fords and are members of the Ford national negotiating machinery are now attempting. Mr. Wilfred Beard, former chairman of the TUC, general secretary of the United Patternmakers' Association, is heading a committee of six.

The substance of the shop stewards' views is that many of the strikes have come about after disputes over standards of work, the payment expected when the production rate has been increased and when the number of men making up a gang has been cut. There is something of a divergence between the way the union leaders look at the employee-management relationship and the view of the shop stewards.

More cooperation and a more positive attitude towards increased efficiency are among the things some of the union executives would like to see. They have a feeling that there are shop stewards who take no action until a member of the management acts in a way with which they are not in agreement.

The official union representatives are seeking a meeting with the Ford management at which it is certain that the four-day week, introduced for 18,000 employees, can be discussed. There is a feeling here that the company should have called the unions in for consultation before resorting to short time.

On shorter hours, the company has proposed a 40 hour week, if the men give up their afternoon tea break. This has been rejected with the answer that a week of 40 hours without the tea service is not a real reduction in hours.

India, Australia and Industrial Opportunity

When an industrialist like Mr. John Oldham, the chairman and joint managing director of the electrical and mining equipment company Oldham and Son, of Denton, Manchester, tours for seven weeks in India and Australia, his ideas on industry in those countries and on overseas selling are likely to be worth hearing.

For a start, Mr. Oldham believes that more company chairmen should get overseas and see for themselves. Spending a quarter of his time overseas he concludes that this benefits himself as well as encouraging the men on the spot with the feeling that they belong to the concern.

Despite all his travelling (Oldham's have subsidiaries in India, Australia, South Africa and France) it was ten years since he had visited the Madras, India, factory. Not surprisingly Mr. Oldham found that labour was "very much available" in India. The workers there were intelligent and swiftly acquired skills.

Once production could be brought about with modern machinery, India would be on the way to being a low-cost producing country.

Cutting Costs

Australia, with its standard of living almost equal to that of the United States, proved to be different problem. If the existing standard of living is to be increased higher productivity and lower costs will have to be achieved. Australia, already producing all that she can, needs to produce more in order to export. Mr. Oldham thought that the pressure of economics and of events will bring this about.

Mr. Oldham does not share the fears of those who believe that by setting up manufacturing subsidiaries overseas Britain will eventually be left exporting nothing at all. His company's experience tends rather to be the opposite. In 1949 he visited South Africa, where Oldham's were exporting successfully and decided that the situation was not going to last. To hold the market the goods had to be produced locally. So a plant was set up in South Africa. But since then the parent company back at Denton has gone on growing and the factories have been "busier than ever."

First Barbecues and Now Forges

Burning sausages, or even the spitted chicken, over the barbecue in the United States back garden was bound to be followed by another, even more frontier-style pastime. For the man who likes to mix fireworship with do-it-yourself, an American company is now providing a home forge, complete with electric bellows, instruction book and sufficient steel to turn out a variety of tools and fittings for the house.

Choosing an Economic Timber Shell

Hugh Tottenham, M.A.

Hume and Tottenham, Architects and Engineers

Timber shells have now been designed and built in sufficient numbers that the economic range of spans for each shell form is known. Typical dimensions for a given span are also available for each form.

TIMBER shell roof construction has developed considerably since its introduction to this country in 1957. This rapid advance has only been possible on account of the improvements in the methods of joining timber, as in glued laminated timber, and in the design techniques for shells. Though this form of construction is still in its infancy, it is now possible to arrive at some conclusions about the economics and construction of timber shells.

The following seven forms of shell roof have been, or are now being, constructed in Great Britain:

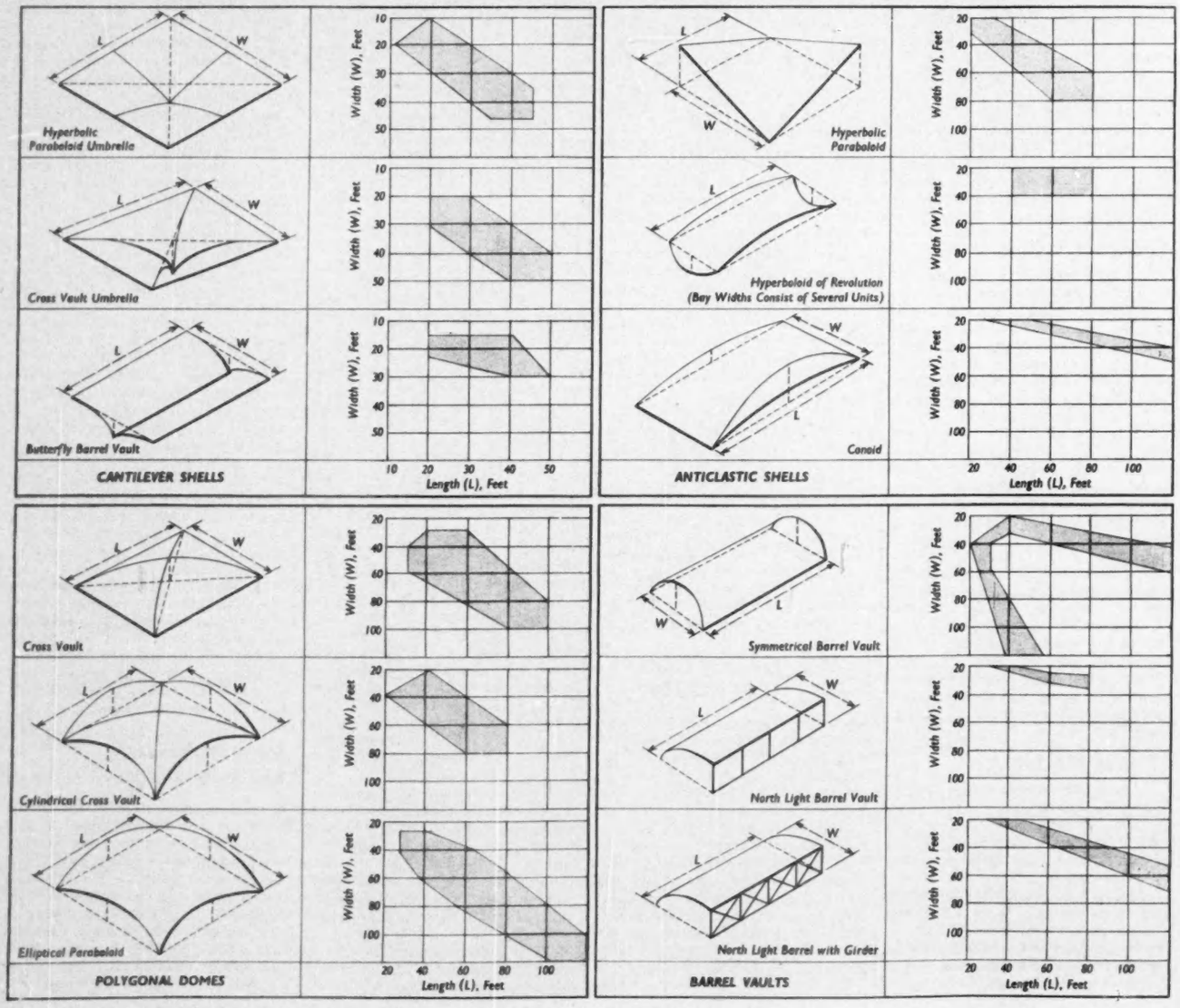
Hyperbolic paraboloid	Vaulted cylindrical dome
Cylindrical	Elliptical paraboloid
Spherical	Folded plate
Conoid	

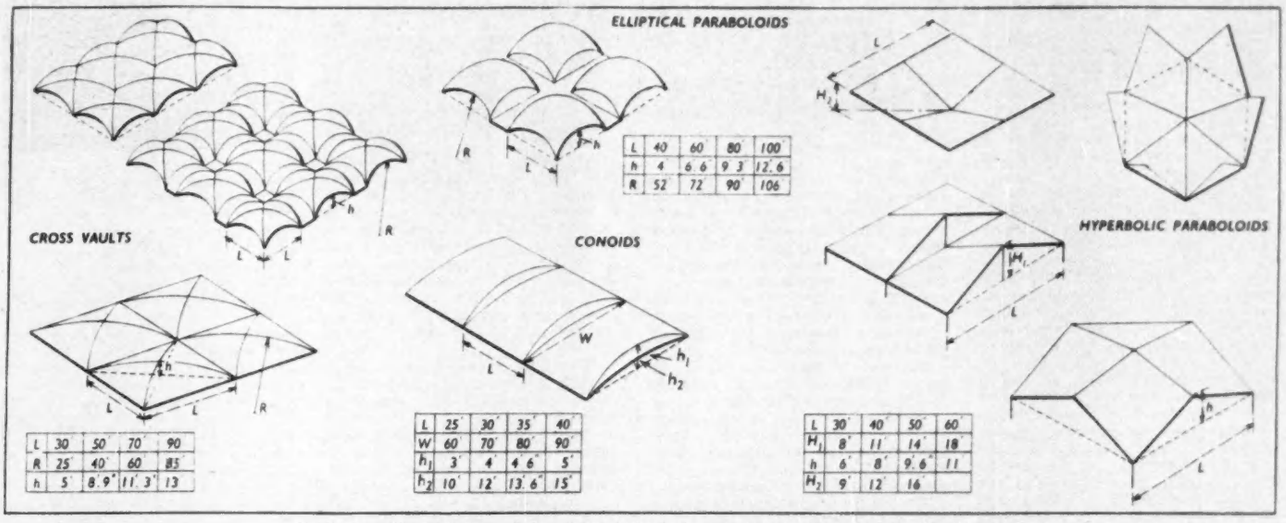
Of these forms, the most popular has been the hyperbolic paraboloid, largely due to the architectural appeal of this shape. It was also thought that this shape, constructed of two sets of straight lines, would be particularly suited to timber. Experience has shown, however, that it is much easier to place the boards in a hyperbolic paraboloid shell along the directions of the diagonals than it is to arrange them along the straight line generators, for it is more easy to hold a board in a slightly curved form than it is to hold in a twist along the length of the board. On this account, it is equally as simple to construct a shell of any shape of double curvature, provided that the radius of curvature is large compared with the thickness of the boards and that the direction of the two sets of lines of principal curvature do not vary too much over the shell. These conditions are satisfied in shallow shells, that is those in which the rise is less than one-fifth of the span, and in shells made up from cylindrical segments.

Shells of positive Gauss curvature—that is, those for which the two centres of curvature are on the same side of the shell—are basically more stiff than shells of negative Gauss curvature, such as the hyperbolic paraboloid and the conoid, but are liable, if the curvature is too large, to local "dimpling" or buckling. The cylindrical shell, with only one centre of curvature, forms an intermediary between these two and requires greater stiffness than either, but this added stiffness is easily obtained by means of light ribs.

A form of construction which is specially suited to timber construction, though it has been largely ignored in concrete, is that made up from cylindrical shell segments and called a "vaulted dome." The shell roof illustrated in Fig. 1, for example, is composed of four cylindrical segments. The ridges along the diagonals give the structure an overall effective double curvature and a much flatter shell could be used than was possible if a simple barrel vault had been

Table I: Shell roof forms, showing their economical range of application according to the required column spacing.





L	40	60	80	100
h	4	6·6	9·3	12·6
R	52	72	90	106

L	30	50	70	90
R	25	40	60	85
h	5	8·9	11·3	13

L	25	30	35	40
W	60	70	80	90
h_1	3	4	4·6	5
h_2	10	12	13·6	15

L	30	40	50	60
H_1	8	11	14	18
h	6	8	9·6	11
H_2	9	12	16	

Table II: Typical dimensions of the principal geometrical shapes for shell roofs.

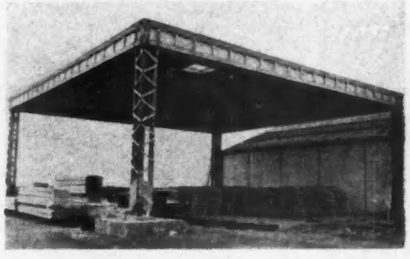


Fig. 1 Four cylindrical segments used to form a vaulted dome. The ridges along the diagonals effect a double curvature, so permitting a very flat shell.

chosen. The shell illustrated, which covers an open storage shed built for the Phoenix Timber Company at Rainham, Essex, is 60 ft square and made up from two layers of boards with light laminated stiffeners. All the stiffeners are of the same shape and of rectangular cross-section. Had an elliptical paraboloid shell been used, the stiffeners would have a similar profile but, owing to change of slope of the shell, the cross-section would vary from rib to rib. Recent examples of a hyperbolic paraboloid (being built for Calibrated Papers Limited at Petersfield) and barrel vault roofs for British Railways are shown in Figs. 2 and 3.

It is not necessary for shells built from cylindrical segments to be square in plan, though the nearer they are to square, the more economical they are to construct. It is also possible to form shells on a polygonal plan in this form. On smaller spans, it is more economical to use folded plate pyramid roofs, particularly if the plan is polygonal, rather than to form curved panels.

In Table I on page 886 are shown several forms of shell roof, together with their economical range of application according to the required column spacing. Naturally, the cost of any particular form depends on the number of such shells to be constructed, the clear height required, column spacing and other factors. The relatively high cost of the temporary scaffolding, and the jigging necessary for the fabrication of the glued laminated ribs and edge members, makes a single shell rather expensive and the economic ranges indicated are based on the assumption that a large number of shells are to be built. Some idea of the variation in cost with span and number of shells is given in Figs. 2 and 3. These two diagrams show the relative costs of different numbers of bays compared with the unit cost of a large number of shells, and the variation of cost with span.

Design techniques for timber shells are not yet as advanced as those used for concrete, due to the lack of isotropy in timber. Ribbed cylindrical shells can be designed as orthotropic shells,[1, 2] but other forms must be designed with a more complex system of elastic constants. It is also important to investigate the possibility of buckling in timber shells even on relatively small spans. It is still necessary to choose an arrangement of boards and (if necessary) ribs, carry out the analysis, and generally then to modify the first arrangement and carry out the analysis again. Several attempts may be necessary before an arrangement having sufficient strength and stiffness in all parts of the shell can be found. As an aid to the initial design, Table II, gives typical dimensions for the principal geometrical shapes.

It is probable that during the next few years there will be considerable improvements in the methods of construction. Better nails have recently become commercially available. These nails not only have improved holding powers, but are also more efficient in shear. Also, adhesive manufacturers are developing glues

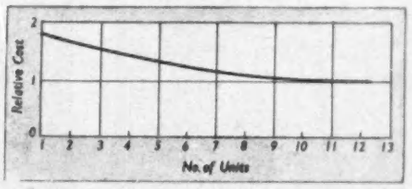


Fig. 4 Relative cost of different members of bays compared with the unit cost of a large number of repeated shells.

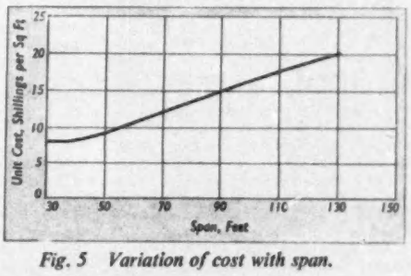


Fig. 5 Variation of cost with span.

suitable for site application. These, and other new techniques, will enable the designer to economise in material and will speed construction. Already a competitive form of construction in large scale applications, timber shell roofs may soon be a common item both in the field and in the engineering design office.

REFERENCES

[1] Tottenham, H., "A Simplified Method of Design for Cylindrical Shell Roofs." *Structural Engineer*, June, 1954.

[2] Tottenham, H., "The Analysis of Orthotropic Cylindrical Shells." *Civ. Eng. and Pub. Works Review*, May, 1958.

Fig. 2 (Left) Typical timber hyperbolic paraboloid shell roofs for a factory at Petersfield.

Fig. 3 (Right) Barrel vault shell roofs for British Railway's new parcel depot at Coventry.

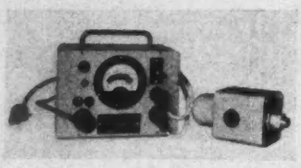
HIGH VACUUM GAUGE

Fluctuating Pressure

A HIGH vacuum gauge has been developed especially for production requirements where the pressure is constantly fluctuating between atmospheric and high vacuum.

The unit is a Penning type cold cathode ionisation gauge which has a range from 10^{-3} to 10^{-6} Torr. The gauge head is normally supplied enclosed in a metal case together with the magnet. Connection of the head to the vacuum system is through a ½ in Pulsometer vacuum union and the control is by a 4 ft length of high voltage cable. If required the head can be supplied with a flanged adaptor plate.

The construction is a ring anode with two plate cathodes, one on either side, sealed in a glass bulb connected to the vacuum system. A permanent magnet produces a field directed along the axis of the electrodes. At the cathodes field emission takes place and the magnetic field causes the electrons to travel in helical paths. Thus although the dimensions of the gauge may be



much less than the mean free path of the atoms at the pressure in the gauge, the actual distance travelled by electrons is greatly increased together with their chance of ionising by collision. The final result is that electrons oscillate between the cathodes in helices and, since the anode has small area, they can cause many ions to be formed before being lost to the anode. The ionisation current for a given electron current is therefore very large and so can be measured directly on a microammeter without any need for amplification.

Typical applications for the gauge include the detection of small leaks in the manufacture of lamps, electronic valves and cathode ray tubes and for processes involving vacuuming coating. *Pulsometer Engineering Company Limited, Nine Elms Iron Works, Reading, Berkshire.*

CASE SEALING MACHINE

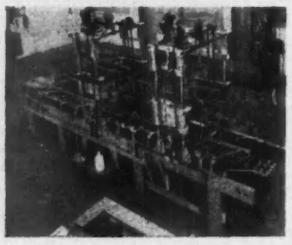
Random Sizes

BOTH taping and gluing operations on cartons of random size are carried out automatically by a new machine.

The machine is designed to operate in a continuous line or from hand feed. The model illustrated will be mounted in a pit so that the conveyor will be a ground level. The handling rate is from 4 to 12 cases per minute according to size.

The cases to be sealed are fed on at the left-hand end, without regard to size, and are timed by a flight bar into sequence. A sensing device actuates the measuring head which is lowered until contact is made with the case top, setting the height for the first gluing operation. The bottom outer flaps of the case open slightly and a guide opens the top flaps. As the case moves forward a continuous strip of glue is applied to both top and bottom inner flaps.

The case moves on, and operates a second size sensing device which adjusts the height of the taping head. The flaps at top and bottom are closed by



rollers on the top and a plough on the bottom, and gummed tape is moistened and pressed on to the case by sponge-rubber covered rollers. The length of tape is controlled by the case size. The tail of the tape is firmly pressed down and the case is passed to the discharge conveyor.

Once the case has been fed on to the receiving conveyor the sequence of operations is completely automatic. The action is electro-pneumatic. The water baths for the tape are fitted with heaters and the gluing station has gear pumps to keep the glue circulating. *Frederick C. Kane Limited, Park Royal, London, NW10.*

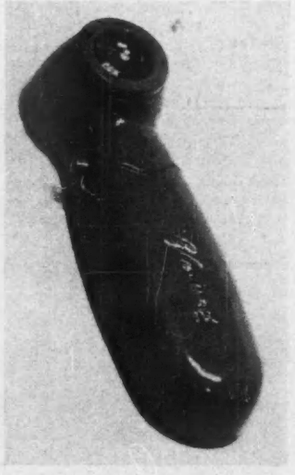
POCKET MAGNIFIER

Illuminated

DETAIL can be clearly brought out on items being inspected with the aid of a new pocket magnifier.

The Glo-Mag lens has a power of 44D (that is, a magnification of 11 times) and embodies its own source of illumination. The case is made of strong lightweight plastic and is designed to rest flat on the bench over the object. The eye must be brought close down to the lens to obtain the full resolution. Alternatively, of course, the magnifier can be held in the hand close to the eye.

The illumination is supplied by a torch bulb which is powered by two standard U12 batteries contained in the handle. The base, which springs into place, carries the bulb. Contact is made by a thumb switch on the left side which works against a spring so that the current cannot be left on accidentally. The overall dimensions are approximately 5¼ in long by 1½ in wide. The area under the viewing lens has a diameter of approximately 1¼ in, giving a field of view over ½ in diameter. The height to



the top of the lens mounting is 1½ in. *Combined Optical Industries Limited, Plasta Works, Bath Road, Slough, Buckinghamshire.*

SHOVEL LOADER

1½ cu. Yard Capacity

LATEST addition to the Frontloader range of four wheel drive shovels is the model 80A.

This machine is powered by the Ford 590E 6-cylinder engine which develops 80 hp at 1,850 r.p.m. A single stage 3 : 1 stall ratio torque converter and full power-shift epicyclic gear train transmit the drive to the axles which have a four pinion differential, crown and pinion spiral bevel primary reduction, and final planetary reduction in the hubs. Two forward and one reverse speeds are available of 4·8, 10·5 and 5·3 m.p.h. respectively.

Hydraulic brakes are fitted to all four of the equal sized wheels and are of the internal expanding shoe type with Hydrovac servo assistance. All wheels are fitted with 12 by 24 8-ply earth moving tyres as standard and 13 by 24 tyres are optional. Steering is power assisted to the rear wheels through a heavy duty Marles box.

All hydraulic rams are double acting and are controlled through a valve that

has detent positions to give semi-automatic raise and float for faster working. The mobile load lifting capacity is 4,000 lb and the maximum crowd or pryout force is 10,000 lb.

The standard bucket is 7 ft 1½ in wide to cover the full width of the machine and has a SAE rated capacity of 1½ cu. yd heaped, or 1¼ cu. yd struck. Smaller and larger capacity buckets are also available for special materials. Maximum height of the bucket under the hinge pin is 12 ft 9 in with a corresponding discharge height of 10 ft 8 in. At 6 ft discharge height, the forward reach is 4 ft 8½ in. The overall length of the machine is 16 ft 2 in with the bucket on the ground. Track, front and rear, is 5 ft 11 in. The operating weight is 6 tons 5 cwt. *Merton Engineering Company Limited, Faggs Road, Feltham, Middlesex.*

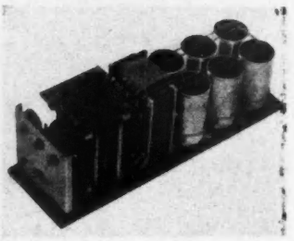
POWER SUPPLY

Stabilised d.c.

THE series PST power supply units are designed for incorporation in electrical equipment requiring a stabilised d.c. source.

The unit consists of a conventional d.c. power supply, made up of a step-down transformer, bridge rectifier, and reservoir capacitor smoothing, the input to which is fed through a transductor. A transistorised feed back amplifier measures the output voltage from the supply and continually adjusts the d.c. current on the control winding of the transducer so as to maintain the output voltage constant over a wide range of variation of mains input voltage and frequency, and of output load current.

The supply unit has no valves and is of high reliability. Ripple is of the order of 1 per cent. The output voltage is adjustable over a range of about 15 per cent about the nominal value, a feature which is of considerable advantage in marginal testing. The reservoir has high capacity. An important feature of the units is the high degree of inherent



protection they possess against short circuits.

There are five models in the series with nominal voltage outputs of 12, 20, 24, 32, and 48 V. Corresponding current outputs are 8, 5, 4, 3, and 2 A. All models are available for chassis mounting or for standard 19 in rack mounting. Versions for ratings other than the standard ones quoted above can be supplied to order. Chief applications are for transistor power supply in computers and similar equipment, stabilisation of low voltage filaments, battery elimination and float supply in telephone equipment. *Claude Lyons Limited, Valley Works, Hoddesdon, Hertfordshire.*

WORK TRAY

For Bolting to Ladders

A PLATFORM or tray that will bolt on to a ladder provides a depository for tools as well as a working surface.

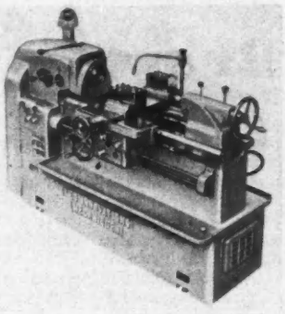
The tray is made of steel and aluminium and is more than 4 ft wide. At the centre, a V has been cut out which will comfortably span fall pipes, or will fit the corner of a building. The bolting arrangements can be adjusted to fit most wood or metal ladders over an extensive range of widths, and allow the tray to be positioned at the height required. The arms of the tray are spring loaded and the provision of ball castors allows the ladder to be raised or lowered with ease, or moved along the wall-face when one section is finished.

On the tray itself there are hooks for paint pots and a wood insert to which a vice can be fitted and on which chisels can be used without fear of damage. Claims for the tray include time saving by allowing the workman to have all his tools with him and so cutting out repeated journeys up and down the ladder, and safety as the large surface

reduces the chance of a dropped tool. It can even eliminate the need for scaffolding. *General Trade and Equipment Limited, 82-90 Seymour Place, London, W1.*

LATHE

General Production Work



ROBUSTNESS and accuracy are two claims for the T6 lathe made by Innovations Mechaniques.

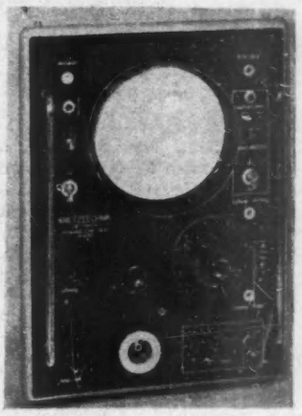
The frame and bed unite to form an extremely rigid structure and the bed section is double walled and made of high strength cast iron. The runways are case hardened and tempered steel, sunk in the bed and trued after fitting. Chips and swarf are disposed of through large elliptical openings at the back. This allows the bed to be solid at the bottom.

The headstock is the single pulley type with a range of 20 speeds in geometric progression covering from 45 to 2,000 r.p.m. Clutch and brake are controlled by a single lever. Two levers control the speed changes. The spindle runs in three conical roller bearings, and is bored to 1¼ in. The saddle has symmetrical guideways and the movement is controlled by levers. Adjustable stops allow four cutting steps to be set in the forward cross movement of the saddle and another one in the reverse. Four similar stops give longitudinal steps. The feed box gives nine feeds, also in geometrical progression, ranging from 0·05 to 0·80 mm.

The lathe will swing 17½ in diameter above the bed and 15½ in over the saddle. The distance between centres is 27½ in. The drive can be by a 9 or 12 hp motor. Quick operating chucks can be fitted and a form copying attachment is available. *Dowding and Doll Limited, 346 Kensington High Street, London, W14.*

THICKNESS GAUGE

High Resolution



HIGH resolution is one of the claims for the Kretz ultrasonic thickness measuring equipment now available.

The equipment incorporates a high stability wide band amplifier having a frequency range of 3 Mc/s to 20 Mc/s and has been specially designed to include facilities for the accurate measurement of dilation or contraction and a special triggering circuit to give warning at a predetermined limit of measurement.

The unit has an effective depth range from 1 cm to 70 cm for flaw detection, and for thickness gauging a maximum of 20 mm dependant on frequency and attenuation of the material under test. A low voltage socket is provided, use of which automatically makes the high voltage connection inoperative.

Thickness measurements are accurately obtained by spanning several pulses with a movable pedestal whose leading edge can be moved to divide the first cycle of each ringing pulse. The higher the number of echo pulses used for the measurement, the greater the discrimination obtained. The vertical deflection response of the trace is better than 0·05 microseconds so that an echo time discrimination of 0·0125 microseconds is obtained. *Aveley Electric Limited, Ayron Road, Aveley Industrial Estate, South Ockendon, Essex.*

CRUCIBLE FURNACE

Tilting Basin

A NEW basin tilter furnace, model BT-1300, extends the range to 1,300 lb capacity of aluminium.

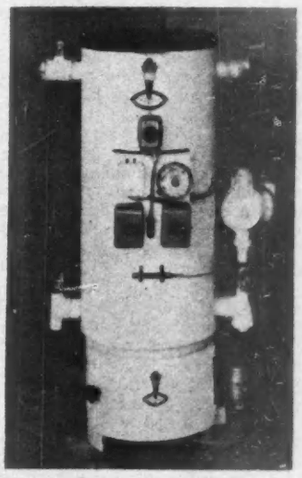
The furnace is oil fired and the melting rate is 1,300 lb per hour. If desired, nitrogen degassing can be used to protect the metal in the crucible from contamination. It is claimed that the table height platform coupled with the wide basin type crucible simplifies charging, making the furnace suitable for melting large or bulky scrap.

The lip pouring is under hydraulic control giving good regulation and allowing ladles to be kept in one position during the whole pour. Metal loss during melting is said to be less than 1 per cent. A fan is needed, delivering 250 cu. ft per minute of air at 25 in water gauge, but it is possible to blow a battery of furnaces with one large capacity fan. A dial pressure gauge acts as a burner control guide and the maximum oil consumption is 11 gallons per hour.

The furnace is lined with high grade firebrick and backed with insulating brick to ensure cool working conditions, high performance and long life. Overall dimensions of the installations are 11 ft 2 in long by 5 ft 9 in high and 7 ft deep. The weight of the complete furnace is 80 cwt, and of the body alone 50 cwt. *Morgan Crucible Company Limited, Battersea Church Road, London, SW11.*

OIL FIRED BOILER

Natural Draught



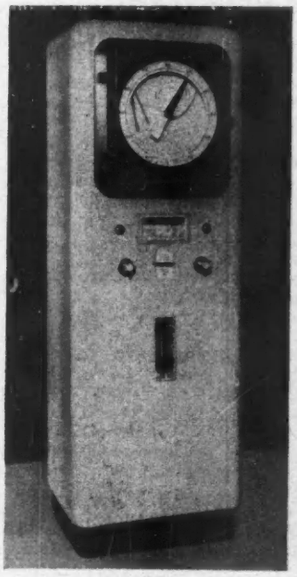
EXTENSIONS to the Permatic range of natural draught oil fired boilers bring the range up to six with capacities from 35,000 Btu per hour up to 80,000 Btu per hour.

These are packaged units ready for installation and available in three forms. Model A has an electric circulating pump, thermostatic control and an 8 ft vacuum jacketed flue pipe with bend. Model B has in addition a prewired panel for control consisting of starters for the boiler and the pump and a 12V transformer. Model C adds an electric time switch for operation control.

These boilers are fitted with pilot ignition which assists in keeping the combustor and flue warm and ready for operation. A series of water tubes is arranged in the body of the boiler, each slightly rotated so that a "spiral" arrangement results. This ensures that all water-wetted surfaces are reached by flue gases. The cylindrical body is completely water jacketed and covered with a layer of insulating material. A white surface finish is used. All models can be supplied with a fire valve as in the illustration if required. *Perkins Boilers Limited, Mansfield Road, Derby.*

CHLORINE RECORDER

Bi-Metallic Cell



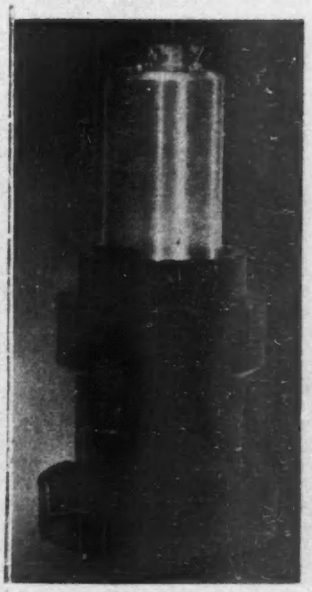
A RESIDUAL chlorine recorder operating on the bi-metallic cell principle is claimed to be less complicated in design than those using the colorimetric method.

The recorder employs a small Perspex constant head chamber of orthodox overflow type in which the sample water is received and measured. The water gravitates through the instrument and therefore in most cases sampling pumps are not required. The incoming supply is controlled by a small valve from the front of the cabinet where the flow is visible at all times. The water mixes with a buffer solution and a mould growth inhibitor in a large chamber.

The treated sample then passes to the cell where the chlorine content is measured by the current passing between two electrodes which are continuously cleaned by a mild abrasive. The current is fed directly to an indicator and recorder chart. Full scale deflection represents 1 part per million. *Paterson Engineering Company Limited, 129 Kingsway, London, WC2.*

TRANSDUCERS

Range of Characteristics



FOUR new transducers offer a range of characteristics for displaying transient phenomena.

Type G304 is an inductance type with provision for water cooling. Displacement of the diaphragm is restricted by a stop, enabling the unit to withstand pressures up to 1,000 lb per sq. in although its normal working range is from 0 to 10 or from 0 to 100 lb per sq. in. Its use is in systems subject to shocks.

Type G302 is an inductance type with flush diaphragm to eliminate dead volume. It can be supplied for pressures from 0 to 10,000 lb per sq. in and will withstand 100 per cent over load. Operating temperatures are up to 150° C. Type G318 (illustrated) is a torsional vibration pickup without rings or moving contacts, working by inductance. The output is directly proportional to the angular movement up to ± 4°. Type G319 is a pressure transducer capable of operating at 500° C without cooling. *Southern Instruments Limited, Frimley Road, Camberley, Surrey.*

Snags in Running a Business Computer

Studies of American electronic data processing installations show that difficulties have arisen through the use of unsuitable staff. Expenses have been high owing to underestimation of programming costs and higher salary bills.

THOUGH it is less than ten years since computers were first used for business data processing in the United States, considerable progress has already been achieved. More large computers have been installed than in Europe and much experience has already been gained. For this reason, a mission of European experts visited the United States from April to June, 1960, under the auspices of the European Productivity Agency. Their report is contained in a booklet, "Integrated Data Processing," published by the Organisation for European Economic Co-operation.

The mission define the integration of data processing as the development of the most streamlined and automatic flow of data that is practicable within an organisation. For small firms this means increased speed of document production, saving in clerical work, and the reduced danger of clerical errors. In big firms, where management has to control on the basis of reported information, the main advantages of integration often lie in improved reporting. But in this case the amount of information is so large as nearly always to demand the use of electronic computers. Electronic data processing was, in fact, the prime concern of the mission.

The mission was made up of 25 participants from 10 European countries. Its chairman was Brian A. Maynard, of Cooper Brothers and Company, London. During its eight weeks stay in the United States the mission saw about 50 industrial and commercial organisations, 30 Government bodies, 13 universities and colleges, five computer service centres, and the principal manufacturers of equipment.

The extent to which the possibilities of integration have so far been exploited was, on the whole, disappointing to the mission. Most undertakings have not yet fully appreciated the possibilities offered by company-wide integration or have been unwilling to pioneer. They may either have been reluctant to face the major changes in organisation and methods involved or have been deterred by the high initial costs of changing over—several companies did not expect that their installations would pay off in less than seven years.

Partial integration has been attempted in specific areas: the sales area—including the processing of inquiries, quotations, sales orders, sales invoicing, manufacturing and dispatch documents, finished goods stock, credit control and accounts receivable, and sales reporting statistics; the production control area—including the processing of product plans, stock control at all stages in manufacture, product manufacturing methods, progress control, payroll, and costs; and the purchasing area—including the processing of raw material stocks, purchase requisitions, purchase orders, overdue deliveries, goods receipts, and accounts payable. Where these schemes involve large volumes of data, they have often been highly successful. So have certain specialised applications such as insurance work, public utility billing, banking, and government work—the routines are fairly well standardised and a computer is well suited to handle and store the large volumes of data involved.

In many instances, management's lack of appreciation of the potentialities of integrated methods, coupled with the natural enthusiasm of the computer team to get started and to gain experience, has been reflected in a tendency to go ahead with individual procedures, such as payroll or sales invoicing, without taking account of their relationships with other procedures or undertaking adequate replanning of methods. For example, the mission saw existing punched card procedures being transferred to a computer without any real assessment of the new possibilities offered by the computer. It is sometimes argued that for the sake of the morale of the team quick practical results are necessary. But it may not be realised at the start, that, once the initial opportunity has been missed, any subsequent attempt to achieve wider integration entails rethinking the procedures and involves the heavy costs of reprogramming and changeover.

While prestige was the inspiration behind some of the initial computer installations in the United States, the mission also noticed a greater readiness on the part of management there to enter any new field that appears to offer opportunities of progress and savings than is general in Europe.

Equipment costs in the United States when converted at the current rate of exchange are almost identical to those in Europe. By contrast the United States level of wages and salaries and other costs are on the average at least twice as high. This means that, although the cost of developing systems and programmes is likely to be lower in Europe under similar circumstances, it is much easier to achieve savings that provide an acceptable return on the cost of an installation in the United States. Economic factors must, therefore, encourage a more rapid development of computers in the United States. This has already been the case with punched-card installations. In the light of such a situation it is important that Europe learns quickly from the difficulties experienced in the US, and the work of the mission is particularly helpful in this respect.

HIDDEN OVERHEADS

When assessing the justification for the introduction of new methods, particular difficulty can arise over placing a value on such advantages as better management reporting and better customer service. Nevertheless, management must evaluate these factors as best it can before it can be in a position to make a proper decision. Apart from this, the preparation of estimates for specific items has often left much to be desired. Some typical weaknesses that were mentioned to the mission are as follows.

The difficulties of estimating the time and effort required to design the new methods, collect the initial data, and instal the procedures were frequently emphasised—especially at the start when the team lacked experience and the extent of the problems was largely unknown. Most early users have stated that they particularly underestimated programming costs, which form a large part of the total. The period during which the old and new procedures must normally be run in parallel has often been underestimated. This can be a material item as it involves not only the cost of running two systems but also that of comparing their results. As experience in the introduction of computers is gained, the level of planning is improved, with a consequent reduction in the period required for parallel operations.

The cost of such items as floor strengthening and air conditioning have often been higher than expected. However, now that more experience has been gained, accommodation presents less of a problem, particularly with the appearance of solid-state computers. A few installations were seen where insufficient space had been provided. This had inevitably resulted in a poor layout and caused hidden losses of time because of inadequate room to arrange papers, cards, and other data, and to carry out maintenance work. The number of magnetic tapes required had frequently been underestimated, particularly where large quantities of data had to be stored for long periods.

Salary costs were often understated through overlooking such factors as the need to continue programming effort after the initial period, both for producing supplementary programmes and for revising the original plans to keep in line with changing circumstances.

Also the increase in salaries to keep staff as they gain experience in this new field is often overlooked. Another tendency noted was that of considering that cards and stationery were too small an item to justify either close estimating or strict control. As their cost sometimes amounts to as much as 15 or 20 per cent of the annual costs it is essential to give them adequate thought. Expected savings in staff are often not achieved. The number of small jobs that remain after the main load of work has been taken over by the computer has often been under-estimated in the initial study. Also, while the planned savings of junior staff may be gained through natural staff wastage, non-essential work may have to be found for more senior staff if there is a policy of providing continued employment. Where only part of several employees' time is expected to be saved by the computer, it may be difficult to organise work within a section so that these partial savings can be consolidated. Unless care is taken there is a danger that additional work will be thought up to fill their spare time.

There have been several instances of delays and difficulties caused by lack of liason with the staff of other departments not directly involved in new electronic data processing activities. Resistance to change and a natural fear of redundancy are best dispelled by the exchange of ideas through lectures and discussions. Here, managers have sometimes lost faith in an installation team whose enthusiasm has led it to make extravagant claims and to over-simplify the problems before any detailed study has even been started. In appropriate cases, similar care must be taken to keep Trade Union representatives fully informed.

The importance of firm management direction and interest to the success of the installation and operation of an electronic data processing system was emphasised repeatedly. And it is important for management to ensure that staff of the proper calibre and experience are employed.

The facilities available for post-graduate management training in the United States are quite unparalleled in most parts of Europe. As a result, each year many thousands of engineering, science, and arts graduates are able to go on to two-year post-graduate courses in business administration. Serious attempts are now being made to cater for such students whose effectiveness in their subsequent careers would be increased by knowledge and experience of computers. Over 100 university schools in the United States already have electronic data processing installations, and many other institutions have access to nearby installations. Manufacturers in the United States have been following an enlightened policy of presenting or lending computers to educational establishments. In this way they are subsidising a flow of trained personnel into industry and commerce who are conscious of the possibilities of electronic data processing, in addition to providing a source of programmers and computer engineers.

Invaluable pioneer work carried out by the US Government installations has played a major part in assisting the development of equipment. In all, over 350 computers have been ordered or installed by government departments for routing data processing work of an administrative nature. The government can make a valuable contribution on coordinating the efforts of manufacturers.

Material Comprehension

ADVANCES in the nuclear field are often arrested by the metallurgical limitations or lack of understanding of the elements involved. With the comparatively recent advent of the nuclear industry, concentrated research has been necessary on elements that were previously poorly understood. For example, a better grasp of the properties of nuclear materials has helped to make possible progressively higher rates of heat transfer in the civil nuclear power stations.

Magnox A 12

Studies have been made into the creep ductility and high temperature fatigue behaviour of the magnesium base alloy Magnox A 12 currently used for the canning material in Calder Hall and Chapelcross reactors. The region of minimum ductility at low temperatures, where intergranular cavitation is most prevalent, has been carefully examined, and the effects of temperature, strain rate and grain size on both ductility and cavitation have been investigated. A survey of fatigue strength has been taken over the range from 225° C to 500° C and in the area of minimum fatigue strength between 400 and 450° C a more intensified study was undertaken. An increase of grain size raised the fatigue strength between 400 and 500° C. The stress level governed the type of failure: Fig. 1 (*a*) shows a high stress failure caused by intergranular cracking with comparatively few cavities present; in low stress tests the failure occurred by the linking up of closely spaced cavities (Fig. 1 (*b*)). ("The Creep and High Temperature Fatigue Properties of the Magnesium Base Canning Alloy, Magnox A 12."—P. E. Brookes *et al.*, Paper No. 2017, Institute of Metals.) It has also been suggested that the addition of zirconium to binary magnesium-manganese alloys, by decreasing the solubility of the manganese, reduces the amount of this element required to secure precipitation hardening effects. ("Creep-Resistant Magnesium Alloys for Nuclear Fuel Elements."—G. C. E. Olds *et al.*, Paper No. 2016, Institute of Metals.)

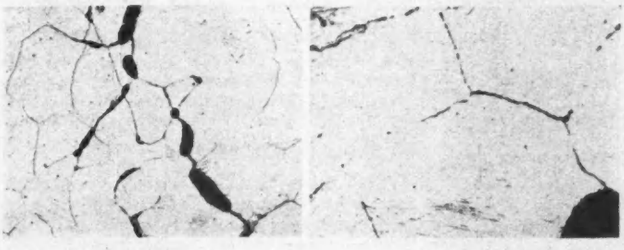


Fig. 1 (left) (a) Typical cracking in short-term fatigue test at 400° C (6·4 × 10³ cycles to failure) × 100 is shown on the left of the illustration. On the right (b) are typical cavitation in long-term fatigue test at 400° C (5·9 × 10⁴ cycles in failure) × 40.

Radiation Effects

Tests on full-length fuel pins have been presented in a paper "Irradiation Testing of Enrico Fermi Prototype Fuel Pins in the CP-5 Reactor" by M. A. Silliman *et al.* at the Symposium of the American Society for Testing Materials on Radiation Effects and Radiation Dosemetry. Burnups ranging from 0·27 to 0·85 per cent of the total atoms undergoing fission have verified predicted high-temperature burnups allowable, but have shown that under certain conditions excessive swelling could occur at low temperatures. Through correlation of diameter measurements, temperature and post-irradiation metallographic analysis, it has been concluded that the radiation stability of the alloy depends heavily on the metallurgical condition of the material. The gamma phase, stable above 1,060° F, resists radiation more effectively than the alpha and delta phases, which are thermally stable at temperatures below 1,045° F. Charpy V-notch and drop weight specimens showed that changes of up to 250° F in the transition temperature were possible for various irradiated steels and weld metals.

Thermocouples in Fuel Pins

Tests in the Experimental Breeder Reactor (EBR-II) at the Argonne National Laboratory found that temperature variations occurring at the centre of the fuel pin could not be calculated with the required degree of accuracy during reactivity and power measurements.

The temperature at the centre of the pin during sudden power transients may reach 2,060° F and much research into the best combination of metals to withstand this heat was required. The combination of tantalum and molybdenum was chosen, since these two metals form alloys with uranium rather than brittle inter-metallic compounds as is the case with chromel, alumel, iridium and the platinum alloys. In addition tantalum and molybdenum have a thermoelectric output of 7 μV per °F and each has a relatively low neutron cross-section. The embedded thermocouple is formed from 0·005 in diameter duplex tantalum and molybdenum wire insulated with swaged magnesium oxide and clad with a 0·045 in external diameter, 0·005 in thick sheath of tantalum. The actual junction is made by removing 0·25 in of the sheathing and insulating the wires with a thin coating of sintered alumina with high-purity silica. This coating is subsequently removed to allow the tips of the wire to alloy with the uranium during the embedding process giving complete electrical continuity.

Solid State Physics

The United Kingdom Atomic Energy Authority has decided to set up a section which will carry out experimental research into the physical properties of crystals including metals, alloys and ionic materials, using the neutron diffraction and irradiation facilities provided by the high flux reactors DIDO and PLUTO. The work will involve a wide range of experimental techniques including levitation, zone melting and metallographic and X-ray investigations.

Fabrication of Curium

Curium 242 can be used as a source of heat in small auxiliary power generators such as the USAEC's SNAP-1A and SNAP-3. The curium is obtained from another aritificial element called americium. The latter is purified by the Nuclear Division of the Martin Company, and is then sealed in small aluminium capsules and irradiated under neutron bombardment converting the americium to curium. Curium is now superseding polonium 210, because it has a longer half-life (163 days compared with 138), better heating efficiency, considerably higher melting point and the fabrication cost on present estimates is much less.

Direct Conversion

Experiments are being undertaken by Atomics International on the core for a direct conversion reactor to be named SNAP 10. The core weighs under 200 lb and is 7 in high and 7 in diameter. The experiments continued until November, and it is now hoped to have accumulated sufficient physical data before completing the design of the final reactor system; at present no electricity is being generated, but it is hoped that the reactor will be in operation next year. The fuel and moderator in the experimental device is a homogeneous mixture of uranium 235 and zirconium hydride. The heat conduction and reflector units are made of beryllium. The device is divided into two identical units which were brought together by remote control to obtain a sustained chain reaction. Each half was built up with alternate layers of fuel-moderator discs and circular conduction plates within a reflector. The complete SNAP 10 system core will be surrounded by thermocouples, and up to 300 watts of electricity will be generated by the flow of heat from the reactor through the thermocouples; any excess heat will be removed by radiation fins to the atmosphere.

Extracting Americium

A method of extracting americium from a mixture of americium and plutonium has recently been discovered, using a ferric salt and an alkali in metal hydroxide to precipitate the americium from the solution. The precipitate is then dissolved in hydrochloric acid and the ferric salt extracted from the americium with an organic solvent (M. Ader and H. H. Hyman, USAEC Patent No. 2,934,403.)

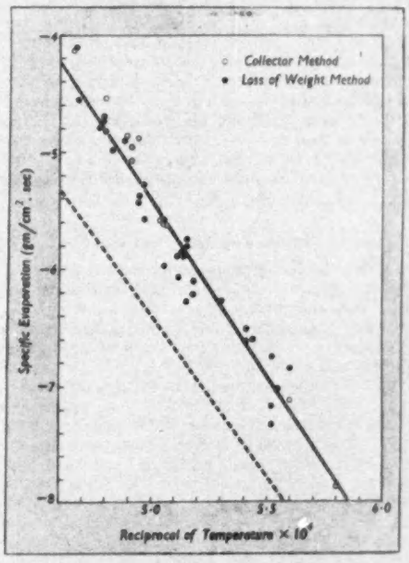


Fig. 2 Specific evaporation rate of thorium against reciprocal of temperature.

Evaporation of Thorium Metal

Re-evaluation of the evaporation of thorium by the Bartol Research Foundation has shown that the previous published data was inconsistent. The measurements were made by observing the loss of weight of the specimens when heated in a tungsten dish by radio-frequency induction, and also by finding the gain of weight in a nearby collector. It was found necessary to conduct the experiments in a vacuum otherwise a golden platina was observed to have formed on the specimen when removed from the apparatus, which was assumed to be due to the surface oxidation of the thorium. Also, the low evaporation rates obtained at the higher pressures were assumed to be due to surface oxidation. The results showed that, although there was considerable scatter, they were consistently 5 to 10 times higher than the previously published data. Fig. 2 shows the specific evaporation rate of thorium plotted against the reciprocal of temperature, the dotted line represents the earlier published values. The heat of evaporation for thorium as derived from these data is about 140 kcal per mol.

Carbon 14 Standard

The National Bureau of Standards has prepared a new carbon 14 standard sample to meet the need created by the increased use of

liquid scintillation counters, particularly in biochemical and medical studies. The solvents usually used in these counters are toluene and xylene, and the standard used in their calibration must therefore be soluble in and compatible with these compounds. Thus benzoic acid-7-C^{14} dissolved in toluene is used for the new standard. The new standard sample may be obtained from the Radioactivity Section, National Bureau of Standards, Washington, DC, for $27·00.

Platinum Adds Resistance to Corrosion

Corrosion resistance to two possible fuels for future homogeneous reactors, uranyl sulphate and uranyl nitrate solutions, of 304 stainless steel alloyed with small amounts of platinum or copper, has been investigated at the Oak Ridge National Laboratory It has been shown that the resistance to corrosion of 18-8 steel is increased by the addition of small amounts of either element. Of the alloys investigated 304 stainless steel containing 0·5 per cent platinum had the lowest rate of corrosion. At 250° C and a solution velocity of 17 ft per sec with a heavy-water solution containing uranyl sulphate and copper sulphate, the corrosion rate was reduced from 35 to 36 mil per year to 15 mil per year by the addition of 0·5 per cent platinum. There was no significant improvement at higher velocities. In a heavy-water solution containing uranyl nitrate and copper nitrate the corrosion resistance at 250° C was increased by the addition of 0·5 per cent platinum at both low and high velocities, and at 70 ft per sec there was a decrease from 300 to 14 mil per year. (Reported in three Homogeneous Reactor Reports, ORNL—2743, 2879, and 2920—by J C. Griess *et al.*).

Plutonium Delivered by Baby Carriage

When the first plutonium extraction plant was put in operation on a pilot-plant scale under the Manhattan Project, there was an acute scarcity of men and materials due to the severe security restrictions. One problem was to find enough flat-topped carts on which the solution batches could be transported without the risk of accidental criticality. The use of baby carriages was suggested and a purchase order was issued for 150. This application proved too much for the auditor's office and the order returned with several queries as to what the US Army wanted with 150 baby carriages. Ignorant of the Manhattan Project, the auditor persisted until someone put forward an explanation sufficiently ambiguous for the auditor to understand. "It wouldn't happen," the auditor replied, "if they tightened up the regulations on men's leave."

Notes and News

18th Session of CERN's Council

Dr. Victor F. Weisskopf has been elected as the new director-general of the European Organisation for Nuclear Research (CERN) by the Council. His predecessor, Mr. John Adams, will be returning to the United Kingdom to be the director of the new laboratory for plasma physics at Culham. M. Jean Williams, head of the Belgian Inter-University Institute of Nuclear Sciences, was elected president of the council.

The organisation has been expanded from six divisions to twelve. Council officials reported that "The decision was reached in order to take into account the fact that CERN has passed from the stage of construction to that of actual fundamental research."

The budget of CERN for 1961 will amount to 67·7 million Swiss francs. This will cover the normal maintenance of the organisation and new experimental apparatus for the two pariticle accelerators.

Spain was accepted by the Council as the fourteenth member of the organisation, which will become effective from 1 January, 1961.

Pipes Float to Destination

Transportation difficulties of an unprecedented nature were encountered by La Société d'Arendonk recently. The company found that the only way to send their Alkathene tubes was by canal. The exceptional length of these tubes—270 yards—excluded all other forms of transport. The polythene tubes are to be used for radioactive effluent drains at the Centre Nucléaire de Mol in Belgium.

Nuclear Courses

The Manchester College of Science and Technology is to hold a two day course on the "Disposal of Waste from the Uses of Radio-isotopes" at the College on 12 and 13 January, 1961. The course is designed for people in industry with no previous background on radioactivity and who wish to become familiar with the subject. Particular emphasis is laid on the disposal of liquid and solid wastes and the importance of safeguarding public health. The fee for the course is £7.

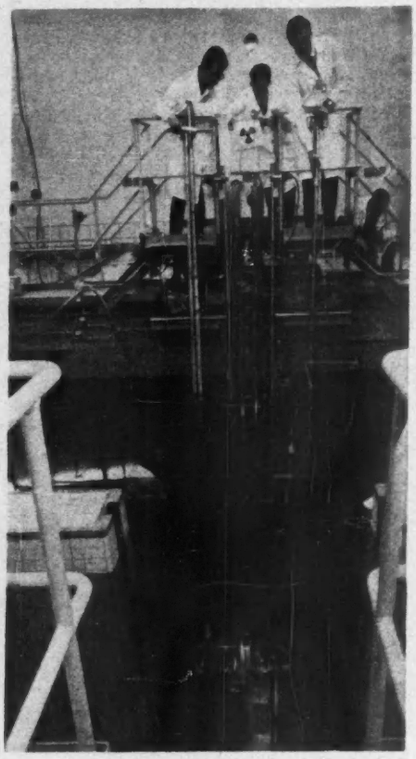


Fig. 3 View of the AMF pool type reactor which will be one of the series to be manufactured under contract by Pye.

The City of Liverpool College of Technology is holding a full-time three month practical course on "Radiation Safety and Health Physics," from 9 January to 28 April. The course will include formal lectures and practical work covering all aspects of radiation hazards and protection. Projects of original work may be undertaken subsequently.

The fourth advanced course on "The Principles of Radiation Protection" is to be held at the Reactor School, Harwell, from 19 April to 18 July.

Reactor Notes

Halden Steam for Paper Mill: The ENEA's heavy-water boiling-water reactor at Halden may at the end of the present experimental programme supply steam to the neighbouring paper mill on a regular industrial basis. The mill uses 100 tons of steam per hour.

New Ideas for Boiling Water: The USAEC have designated the Allis-Chalmers Company to design and construct a 50 MW(e) prototype power plant incorporating a boiling-water reactor of improved engineering design. The Improved Cycle Boiling Water Reactor is planned to be completed in early 1964, and will be the forerunner of a 300 MW unit.

Plutonium Recycle Test Reactor Critical: Initial criticality was achieved on 21 November in the Plutonium Recycle Test Reactor at the USAEC's Hanford Plant. Start-up tests are now in progress and various patterns of fuel loadings will be tested in the core. The design power is for 70 MW(t). The reactor is a heavy water moderated and cooled pressure tube type; it will be used to test plutonium-bearing fuel elements and to develop technology for the use of plutonium as a fuel in civilian power reactors.

Safeguards Reports: The advisory committee on reactor safeguards has approved with certain reservations the operation of four reactor projects involving the indirect-cycle natural-circulation boiling-water power reactor being constructed by Allis Chalmers Manufacturing Company for the Rural Cooperative Power Company of Elk River. A high power-density boiling-water power reactor being built for the Consumers Power Company at Rock Point, Michigan. A controlled-recirculation boiling-water power reactor being constructed for the Northern States Power Company of Minneapolis, and the National Aeronautics and Space Administration's testing reactor at the Plum Brook facility, Ohio. Designed as a 60 MW heterogeneous light-water cooled and moderated reactor. (Atomic Review, 14 Oct. '60.)

Aid for Venezuela: Venezuela was the seventh country to receive assistance from the United States for completed reactor projects, when she received a cheque for $350,000. The reactor will be used for research and training and is fuelled with 20 per cent enriched uranium to operate at 3 MW(t).

Soviet Design: Dr. H. J. Bhabha, chairman of India's Atomic Energy Commission, has said that the Soviet Union has agreed to design natural-uranium and fast breeder power stations for India.

Japanese Nuclear Carrier: A draft plan has been announced by a group of leading Japanese industrial and trading companies for the building of a 46,000 ton nuclear-propelled ore carrier to convey ore from Chile to Japan.

Proposed South Coast Sites: The CEGB have investigated two sites for nuclear power stations at Earnley, Sussex, and Hamstead, Isle of Wight. The rate of increase in demand in the southern counties for electrical power is greater than 10 per cent per annum. The site at Earnley has been found technically unsuitable, but Hamstead on the other hand is excellent apart from a fear that a nuclear station may spoil the amenities of the West Solent. Conventional alternatives are being considered, but these also bring problems.

Pye-AMF Contract: A licensing agreement has been concluded for the manufacture and sale in the United Kingdom and Eire of the American Machine and Foundry Company's series of low-power reactors and ancillary equipment by Pye Limited of Cambridge. Fig. 3 shows the pool type reactor.

Accelerator Notes

Kiev University: A compact accelerator, 40 in long, which produces beams of neutrons with energies up to 14 MeV has been built at Kiev University in the USSR with the initial purpose of making accurate estimation of trace elements in ores.

Accelerator in Transvaal: Potchefstroom University in the Transvaal is to buy a 2 MeV Cockcroft-Walton accelerator. The machine was built in Cambridge and is now being dismantled for operation in South Africa early in the New Year.

LAPORTE CHEMICALS LIMITED

(a member of the Laporte Group of Companies)

Require Senior

MECHANICAL ENGINEERING DRAUGHTSMEN

for interesting work on large chemical plant installations. Experience in the type of work is desirable but not essential and applicants with general mechanical engineering experience will be favourably considered. The posts offer opportunities and salaries consistent with experience and ability. Modern offices situated in the London E.C.4 area. Five-day week and superannuation scheme.

Applications, which will be treated in the strictest confidence, giving details of age, qualifications and experience and quoting REF. LCL/E2/1, should be addressed to:—**The Group Personnel Manager, LAPORTE INDUSTRIES LIMITED, Hanover House, 14 Hanover Square, London, W.1**

D 639

BRITISH CELLOPHANE LIMITED

require a

TECHNICAL SERVICE MANAGER

Applications for the position of Technical Service Manager are invited from men, aged 30/40, having the following qualifications:—

A good Science or Engineering degree.
Successful Management experience.
A balanced interest in current market problems and long-term use development.
Enthusiasm, drive and ability to get on well with people.
A practical knowledge of packaging—particularly in respect of Plastic and/or Cellulose films—would be an advantage.

The Technical Service Manager will be based on London, W.1, and will be responsible for departmental control of Technical Service Representatives, a Laboratory and a Machine Development Section. He will be required to establish and maintain first-class relationship with the Company's customers both in the United Kingdom and overseas by personal contact where necessary. Interviews will take place in London.

Applications to: PERSONNEL OFFICER, BRITISH CELLOPHANE LIMITED, BRIDGWATER, SOMERSET. D 659

Weir

G. & J. WEIR LTD.

DESIGN DRAUGHTSMEN

DESIGN DRAUGHTSMEN are required for original work on new and interesting projects.

MINIMUM qualifications are:—

(*a*) Age 28-40.

(*b*) Higher National Certificate.

(*c*) A recognised apprenticeship.

(*d*) At least three years' design experience in one of the following:

(i) Large power generation auxiliaries, particularly in connection with pumping and heat exchange equipment.

(ii) Reciprocating compressors.

(iii) Automatic process machinery.

(iv) Small to medium sized steam turbines.

Salaries offered will be commensurate with the applicant's qualifications and experience.

The factory is pleasantly situated on the outskirts of Glasgow and working conditions are in accord with the highest standards.

Superannuation and Life Assurance schemes are in operation.

Applications, giving details of education, training and experience, should be addressed to:—

The Chief Designer,

G. & J. WEIR LTD.,

CATHCART, GLASGOW, S.4.

D 646

'Engineering' Appointments Section

PUBLIC APPOINTMENTS

SOUTH WEST METROPOLITAN REGIONAL HOSPITAL BOARD

APPOINTMENT OF DEPUTY REGIONAL ENGINEER

Applications are invited for the appointment of DEPUTY REGIONAL ENGINEER to the Board. This is a responsible post in the team serving the largest Board in the country which is now carrying out an expanding programme of hospital building. The successful applicant must be capable of acting for the Regional Engineer over the whole range of the services for which he is responsible. This is a post requiring considerable ability and initiative.

Applicants must hold corporate membership of the Institution of Civil, Mechanical, Electrical or Structural Engineers, and preference will be given to candidates with considerable experience of large engineering installations in hospitals or public buildings.

The salary is £2015 p.a. rising to £2415 p.a. by four annual increments. This includes a London Weighting allowance.

Enquiries for further particulars may be made to the undersigned.

Applicants are asked to give full particulars of their age, qualifications and experience, and these together with the names of two referees, should be sent to the SECRETARY at 40, EASTBOURNE TERRACE, W.2, with confidential cover and marked "DEPUTY REGIONAL ENGINEER," by 6th JANUARY.

E. G. BRAITHWAITE,
Secretary. D 661

AUSTRALIA

THE UNIVERSITY OF NEW SOUTH WALES

FACULTY OF ENGINEERING

TEACHING FELLOWS

Vacancies for teaching fellows exist in the Schools of Mechanical, Electrical and Civil Engineering. Applicants must possess a degree with honours, and will be expected to enrol for a higher degree and undertake a limited amount of teaching duties. Engagement is on an annual basis to a maximum of three years.

Salary: £A1129 range £A1349 per annum.

Commencing salary for all positions will be according to qualifications and experience.

Further details regarding these positions may be obtained from the Head of the appropriate school. Ship fares to Sydney of appointees and their families will be paid. Four copies of applications (including the names of two referees) should be lodged with the AGENT GENERAL FOR NEW SOUTH WALES, 56-57 STRAND, LONDON, W.C.2, and a copy forwarded by airmail to the APPOINTMENTS SECTION, THE UNIVERSITY OF NEW SOUTH WALES, BOX 1, POST OFFICE, KENSINGTON, NEW SOUTH WALES, AUSTRALIA, before 27th JANUARY, 1961. D 638

NORTH WEST METROPOLITAN REGIONAL HOSPITAL BOARD

Applications are invited for the post of DEPUTY REGIONAL ENGINEER. He will be required to act for the Regional Engineer over the full range of the services for which he is responsible and will be responsible for the day-to-day supervision of the Engineering Department. The Board is engaged on plans for a considerable expansion of the Hospital building programme and the Regional Engineers' Department has recently been reorganised to provide for four engineering teams working on a project basis. There will eventually be an engineering staff of about 45.

Applicants must be Corporate Members of the Institution of Mechanical Engineers and/or Institution of Electrical Engineers.

Salary Scale: £2015 to £2415.

Apply, stating age, qualifications (with dates) and experience, with names and addresses of two referees, to SECRETARY, NORTH WEST METROPOLITAN REGIONAL HOSPITAL BOARD, 40, EASTBOURNE TERRACE, LONDON, W.2, quoting reference 878, by 11th January. D 663

REPUBLIC OF THE SUDAN

Applications are invited to fill the post of CONSTRUCTION ENGINEER with the CENTRAL ELECTRICITY AND WATER ADMINISTRATION (H.Q.), KHARTOUM, SUDAN.

Applicants should have had a recognised engineering training and preferably be in possession of qualifications leading to Corporate Membership of the Institution of Electrical Engineers. They should have had considerable experience in the installation and maintenance of all kinds of indoor and outdoor substation equipment on systems up to 11 kV. Experience on higher voltage equipment and knowledge of testing and commissioning of protection gear will be an advantage. The successful candidate will be expected to travel about the Administration's supply system to supervise the erection and maintenance of all substation plant and equipment and to train Sudanese in this particular work.

Salary offered is in the present range of £81075-£81675 plus a cost of living allowance which is at present approx. £8187 per annum. An outfit allowance of £850 is payable on appointment.

Furnished accommodation is available at a nominal rent of approximately £8180 per annum, free medical treatment will be provided for Official and his family, and free air passages to his home country for leave, which is granted at the rate of 82 days per annum after the first 18 months.

Appointment will be on contract for 5 years including a 12 month probationary period. A bonus of 10 per cent. of basic salary earned will be paid at the end of the contract.

Applications, stating age, general and technica education, qualifications and experience, together with particulars of present appointment and salary, should be sent to the APPOINTMENTS SECTION, SUDAN EMBASSY, 3 CLEVELAND ROW, ST. JAMES'S, LONDON, S.W.1.

Closing date: 15th JANUARY, 1961. D 655

AUSTRALIA

THE UNIVERSITY OF NEW SOUTH WALES

THE NUFFIELD RESEARCH CHAIR OF MECHANICAL ENGINEERING

The University invites applications for appointment to the NUFFIELD RESEARCH CHAIR OF MECHANICAL ENGINEERING, which will become vacant early in 1961.

A salary of not less than £A4279 p.a. will be paid to the successful applicant.

Applicants must have high academic qualifications and experience in some field of Mechanical Engineering.

The research background and interests of applicants are not specified, but the University will be interested in applicants working in the fields of thermodynamics and fluid mechanics.

The successful applicant will be situated within the School of Mechanical Engineering of which the Head is Professor A. H. Willis, and will be expected to supervise an appropriate academic group in the School and to concentrate on research and postgraduate activity in that field.

Subject to the consent of the Council of the University Professors may engage in a limited amount of higher consultative work.

The successful applicant will be eligible subject to satisfactory medical examination to join the superannuation scheme, which provides a maximum pension of £A2184 per annum.

Professors are eligible for six months' study leave on full salary after three years of service, or twelve months after six years of service.

The University reserves the right to fill the Chair by invitation.

With approval of the University and its bankers, married men may be assisted by loans to purchase a home.

First class ship fares to Sydney of the appointee and his family will be paid.

Four copies of applications including the names of three referees and a recent photograph of the applicant, should be lodged with the AGENT GENERAL FOR NEW SOUTH WALES, 56-57, STRAND, LONDON, W.C.2, ENGLAND, and a copy forwarded to the APPOINTMENTS SECTION, THE UNIVERSITY OF NEW SOUTH WALES, BOX 1, POST OFFICE, KENSINGTON, NEW SOUTH WALES, AUSTRALIA, by airmail to reach there before 10th FEBRUARY, 1961. Applicants outside the United Kingdom need only submit one copy of their application to the London address. D 664

BRITISH HYDROCARBON CHEMICALS LIMITED

(Manufacturers of Petroleum Chemicals)

REQUIRE

MECHANICAL ENGINEERS
INSTRUMENT ENGINEERS

Vacancies exist for experienced men and for young graduates in both categories.

Applicants should have 1st or 2nd class degrees (or the equivalent) in mechanical engineering (or, in the case of Instrument Engineers, electrical engineering). Experience in the petroleum chemicals or petroleum refinery industries would be an advantage but is not essential.

The Company has a continuous record of expansion and prospects are excellent. Starting salary will depend on qualifications and experience. There is a non-contributory pension scheme.

Apply with full particulars to Personnel Dept.:

BRITISH HYDROCARBON CHEMICALS LIMITED · DEVONSHIRE HOUSE MAYFAIR PLACE · LONDON, W.1 D 629

CENTRAL ELECTRICITY GENERATING BOARD
ASSISTANT ENGINEERS
PLANNING DEPARTMENT

Applications are invited for the appointment of ASSISTANT ENGINEERS in the System Planning Branch at Headquarters, London, S.E.1

Candidates should preferably possess technical qualifications at least equivalent to Graduate Membership of the Institution of Electrical Engineers. Practical experience in the Electricity Supply Industry is essential, and knowledge of engineering economics will be considered an advantage.

The work of the System Planning Branch is primarily concerned with the initiation and co-ordination of programmes of new generating plant and main transmission. The successful candidates will be required to assist with the study of factors affecting these future developments.

Salaries on scales within the range £1,395-£2,010 p.a., according to duties and responsibilities.

Applications stating age, qualifications, experience, present position and salary, to the PERSONNEL OFFICER, 24/30, HOLBORN, LONDON, E.C.1, by 9th January. Envelopes should be marked "Confidential Ref. ENG/460."

D 650

THE QUEEN'S UNIVERSITY OF BELFAST

THE SENATE OF THE QUEEN'S UNIVERSITY OF BELFAST invites applications for a SENIOR LECTURESHIP in ENGINEERING MATHEMATICS from 1st OCTOBER, 1961. The Department is responsible for teaching mathematics to engineering students throughout the University and candidates should preferably have a research interest in the application of mathematics to some engineering subject. Salary range £1700 to £2275 plus contributory pension rights under the F.S.U. Initial placing on the salary scale will depend on qualifications and experience.

Applications should be received by 30th JANUARY, 1961. Further particulars may be obtained from G. R. COWIE, M.A., LL.B., J.P., Secretary to the University. D 633

WELSH COLLEGE OF ADVANCED TECHNOLOGY,

Cathays Park, Cardiff

ELECTRICAL ENGINEERING DEPARTMENT

Applications are invited for the posts of (i) A SENIOR LECTURER, (ii) A LECTURER, in ELECTRICAL ENGINEERING, duties to commence on 1st MAY, 1961.

Salary: SENIOR LECTURER, £1550 by £50 to £1750 per annum. LECTURER, £1370 by £35 to £1550 per annum.

Applicants should possess a University Degree, together with teaching and industrial experience.

Application forms (together with further particulars) may be obtained from the Registrar at this College, to whom they should be returned by 14th JANUARY, 1961.

ROBERT E. PRESSWOOD,
Clerk to the Governors.

December 12, 1960. D 637

BRUSH ELECTRICAL ENGINEERING COMPANY LIMITED
Loughborough, Leicestershire

(A member of the Hawker Siddeley Group—Industrial Division)

INDUSTRIAL APPLICATIONS ENGINEER

Due to expansion in the industrial applications field this Company has a vacancy for a SENIOR ENGINEER in the Industrial Application Section of the Electrical Rotating Machines Engineering Department. A knowledge of drives in the rubber, plastics and associated industries and of related control systems is essential. Some experience of site testing and commissioning is also desirable.

Applications are invited from fully qualified men and preference will be given to corporate members of the Institution of Electrical Engineers.

Applications, WHICH WILL BE TREATED IN THE STRICTEST CONFIDENCE, should contain brief details of experience and qualifications and should be addressed to Mr. P. A. McCaig, quoting reference: PL.9904.

Brush Electrical Engineering Company Limited, Loughborough, Leicestershire

D 609

UNIVERSITY OF WALES
UNIVERSITY COLLEGE OF SWANSEA
DEPARTMENT OF ENGINEERING

Owing to the large expansion of the Departmental facilities for both teaching and research, a number of appointments will be made to the Staff both immediately and from OCTOBER 1st, 1961. Applications are invited from graduates in Engineering, Physics, Metallurgy or Applied Mathematics for the following posts:—

CIVIL ENGINEERING
Professor B. G. Neal

LECTURER or ASSISTANT LECTURER with interests in any branch of Civil Engineering.

CIVIL OR MECHANICAL ENGINEERING

LECTURER or ASSISTANT LECTURER with special interests in Strength of Materials and related fields.

MECHANICAL ENGINEERING
Professor R. H. Macmillan

Two LECTURERS or ASSISTANT LECTURERS, one with particular interests in the fields of Heat Transfer and Thermodynamics, the other preferably having experience in the Design of Machines, but applicants with other interests will be considered.

RESEARCH DEMONSTRATOR to undertake a limited amount of teaching and pursue supervised research preferably in Heat Transfer, Hydrodynamic Power Transmission, Fatigue or Creep.

ELECTRICAL ENGINEERING
Professor W. Fishwick

LECTURER or ASSISTANT LECTURER with special interests in Control Engineering, Electrical Apparatus or related fields.

LECTURER or ASSISTANT LECTURER with interests in any branch of Electrical Engineering, including Theoretical Electro-technics.

Qualifications for, and further details of, these posts are as follows:—

LECTURER. Applicants should hold a good Honours degree and have not less than three years' post-graduate experience in research or industrial design. Excellent facilities exist for research.

ASSISTANT LECTURER. Applicants should hold a good Honours degree and have at least one year's industrial or post-graduate experience. Research is strongly encouraged and the assistant may register for a Ph.D. degree.

RESEARCH DEMONSTRATOR. Applicants should have obtained a good Honours degree and have had at least one year's industrial or post-graduate experience. The appointment will be tenable for three years, during which time the holder will be expected to work for the Ph.D. degree, submitting a thesis at the end of the period.

Salaries are on the following scales, to which are added F.S.S.U. benefits and family allowances:—

LECTURER: £1050 by £50 to £1400 by £75 to £1850 per annum.

ASSISTANT LECTURER: £800 by £50 to £950 per annum.

RESEARCH DEMONSTRATOR: £700 per annum.

Further particulars can be obtained from the REGISTRAR, UNIVERSITY COLLEGE, SINGLETON PARK, SWANSEA, by whom applications (two copies) must be received not later than SATURDAY, JANUARY 21, 1961. D 635

ENGINEERS

D.S.I.R., ROAD RESEARCH LABORATORY, HARMONDSWORTH, MIDDLESEX, requires ENGINEERS (CIVIL OR MECHANICAL) as SCIENTIFIC OFFICERS or SENIOR S.O.'s to conduct research on: (1) Mechanical mixing and laying of bituminous road surfacing materials. (2) Problems of design and construction of earthworks for roads (practical experience of site work an advantage). (3) Stabilised soil and cement-bound base materials. Varied and interesting work both in laboratory and field, providing contacts with other engineers, chemists, physicists and mathematicians in U.K. and abroad. Facilities for qualifying for A.M.I.C.E. Quals: 1st or 2nd class Hons. Degree in Civil or Mechanical Engineering or equivalent. For S.S.O. at least 3 years post-graduate experience required. Salary ranges (men): S.O. £730-£1,205; S.S.O. £1330-£1640. Normal prospects of promotion in mid-thirties to P.S.O. (£1700-£2375).—Forms from MINISTRY OF LABOUR, TECHNICAL AND SCIENTIFIC REGISTER (K), 26 KING STREET, S.W.1, quoting reference number E473/OA. Closing date 20 February, 1961. D 640

UNIVERSITY OF ABERDEEN
and
ROBERT GORDON'S COLLEGES

Applications are invited for the post of UNIVERSITY LECTURER IN MECHANICAL ENGINEERING. Candidates should have special qualifications in applied thermodynamics. An interest in Heat Transfer apparatus and some industrial or research experience would be an advantage. Excellent facilities for research or advanced studies. University regulations permit members of teaching staff to read for degree of Ph.D. by research. Salary on scale £1050-£1850 with placing according to qualifications and experience. University houses available from time to time. Appointment to date from as early as possible in 1961.

Further information may be obtained from the SECRETARY, THE UNIVERSITY, ABERDEEN, with whom applications (20 copies), giving the names of three referees, should be lodged not later than 31 JANUARY, 1961. Applicants outside the British Isles may submit one copy of application. D 656

SENIOR PROJECT ENGINEER

required for the Central Engineering organisation of an active and flourishing Chemical concern in the North of England with international interests.

The duties attached to the post are the direction and co-ordination of the engineering activities of a group of projects concerned with the Company's expansion at home and overseas. The post is primarily concerned with design and procurement and not directly with site work.

A wide engineering experience is essential, including Civil, Electrical and Instrument engineering, with emphasis on Mechanical Engineering Design and Chemical Plant layout.

Applicants must be University graduates in Mechanical/Electrical Engineering and have served an apprenticeship, followed by at least ten year's experience in the Chemical industry.

A salary of the order of £2500 is offered and interested Engineers who fulfil the above qualifications may write in strictest confidence to BOX D 625, Offices of ENGINEERING.

UNIVERSITY OF CAMBRIDGE
CHAIR OF MECHANICS

Applications are invited for the newly established Chair of Mechanics. The appointment will be subject to the Statutes and Ordinances of the University. The Professor will be required to assist in the organisation of, and to take part in, the teaching of Mechanics and Mechanics of Machines for the Mechanical Sciences Tripos, and to direct research in those fields. Further information on the scope of the work, the facilities available and planned, and the organisation of the DEPARTMENT OF ENGINEERING may be obtained from the REGISTRAR, THE OLD SCHOOLS, CAMBRIDGE, to whom applications should be sent so as to reach him not later than 21st JANUARY, 1961. D 647

OXFORD UNIVERSITY

There is a vacancy in the University Surveyor's Office for a MECHANICAL ENGINEER to co-ordinate the design of heating, ventilating and electrical equipment and plant in new building projects. He will be responsible under the Surveyor for liaison between departments and architects and specialist consultants, and will also be required to exercise a general supervision of the maintenance and repair of existing installations.

He must be a qualified mechanical or electrical engineer, or a graduate in engineering. Salary will be in the range £1500 to £1850. The successful applicant will be entitled to membership of the Federated Superannuation System for Universities, and would qualify for children's allowances of £50 per child per annum.

Further details and forms of application from the SURVEYOR TO THE UNIVERSITY, THE MALTHOUSE, TIDMARSH LANE, OXFORD. D 603

Ferranti transformers

Vacancies exist for

SENIOR & JUNIOR TRANSFORMER DESIGNERS

DEVELOPMENT ENGINEERS · DRAUGHTSMEN

in the Manchester branches of the Company

FOR DESIGN AND DEVELOPMENT

applications will be considered from holders of honours or pass degrees in Electrical Engineering or Physics, or of H.N.C. in Electrical Engineering. For Senior Design vacancies previous experience of transformer design is desirable.

FOR DRAWING OFFICE

H.N.C. in Mechanical Engineering is desirable and experience of transformer work or of the design of welded structures would be an advantage.

Applicants should send brief details of their qualifications and experience to:-

T. J. LUNT, Staff Manager
Ferranti Ltd., Hollinwood, Lancs.
and quote reference FWG

These vacancies offer EXCELLENT PROSPECTS AND HIGH TECHNICAL INTEREST. Successful candidates will be joining the foremost British transformer manufacturing company, with advantages of:-

- THE MOST UP-TO-DATE DESIGN AND DEVELOPMENT FACILITIES
- TECHNICAL LEADERSHIP
- A MANUFACTURING CAPACITY OF OVER 5,000,000 kVA PER ANNUM
- WORLD-WIDE INTERESTS

They will have the opportunity of being associated with activities such as:-

The recent order for one of the first two 380 kV 400 MVA transformers for the C.E.G.B., the almost completed contract for the 330 kV transmission transformers for the Kariba Dam Scheme etc.

The use of high voltage equipment such as 4,000,000 Volt and 1,500,000 Volt impulse generators, a Pegasus 2 computer etc.

MAJOR CONTRACTS IN TRANSFORMERS AND HIGH VOLTAGE EQUIPMENT IN 5 CONTINENTS.

Interviews will take place shortly and may be arranged for Saturday, if requested.

D 667

UNIVERSITY OF ST. ANDREWS

Applications are invited for a SENIOR LECTURESHIP or a LECTURESHIP in ELECTRICAL ENGINEERING in the DEPARTMENT OF ELECTRICAL ENGINEERING, QUEEN'S COLLEGE, DUNDEE, to commence not later than 1st OCTOBER, 1961. It is intended to appoint the most suitable candidate irrespective of his particular interest. Salary scales: Senior Lectureship, £1925 by £75 to £2425: Lectureship, £1050 by £50 to £1400 by £75 to £1850 (efficiency bar £1400). F.S.S.U. Family Allowance. Grant towards furniture removal expenses.

Applications (6 copies) containing the names of three referees, to the undernoted, from whom further particulars may be obtained, not later than 21st JANUARY, 1961.

PATRICK CUMMING,
Joint Clerk to the University Court,
Queen's College, Dundee.

December, 1960. D 630

UNIVERSITY OF AUCKLAND
NEW ZEALAND
CHAIR OF ENGINEERING
(MECHANICAL)

Applications are invited for the above-mentioned appointment, which carries the right of private consultative practice under certain conditions.

The salary will be £2800 per annum and travel and removal expenses will be allowed within specified limits.

Unfurnished accommodation is provided at a moderate rental.

Further particulars and information as to the method of application should be obtained from the SECRETARY, ASSOCIATION OF UNIVERSITIES OF THE BRITISH COMMONWEALTH, 36 GORDON SQUARE, LONDON, W.C.1.

Applications close, in New Zealand and London, on 7th FEBRUARY, 1961. D 660

ENGINEER

B.B.C. requires ENGINEER, BUILDING DEPARTMENT, to arrange and supervise contracts for installation and maintenance of lifts, maintenance of boiler, heating and ventilation services, refrigeration plant, gas services, etc., in the London area. Work includes liaison duties with Departments concerned with the day-to-day operation and upkeep of plant and services. Applicants, aged 35/45, should have commenced their careers with a mechanical engineering apprenticeship, preferably in heavy electrical industry, and have had considerable experience as a works engineer dealing with operation and maintenance of all building services. Salary scale £1230 to £1580 p.a.—Write for application form to ENGINEERING RECRUITMENT OFFICER, BROADCASTING HOUSE, LONDON, W.1, quoting Ref.: EX.60.60.Engg.

D 668

LEWISHAM GROUP
HOSPITAL MANAGEMENT COMMITTEE
SUPERINTENDENT ENGINEER

Applications are invited for the position of SUPERINTENDENT ENGINEER who will be responsible for the operation, maintenance and co-ordination of the engineering services and activities, in this large and important group of hospitals; the supervision of maintenance works and staff, and the keeping of all necessary records, etc. Post vacant 1 April, 1961.

Applicants should be qualified in accordance with the Ministry of Health requirements.

Salary scale £1130-£1325, plus £50 London Weighting Allowance. In addition, at the present time, a long hours gratuity at the rate of 6½ per cent. of salary is also payable.

Applications giving details of qualifications and experience, present and previous posts, etc., together with the names and addresses of two referees, should be sent to the GROUP SECRETARY, LEWISHAM HOSPITAL, LEWISHAM, LONDON, S.E.13, by not later than 21 JANUARY, 1961.

D 662

UNIVERSITY OF EDINBURGH

Applications are invited for I.C.I. RESEARCH FELLOWSHIPS in BIOCHEMISTRY, CHEMISTRY, ENGINEERING, PHARMACOLOGY, PHYSICS or CHEMICAL TECHNOLOGY (CHEMICAL ENGINEERING), normally tenable for a period of three years. Some appointments will date from 1st October, 1961 (or earlier in the case of selected candidates who may be available before that date). The initial salary will depend upon qualifications and experience, but will normally be within the range £800 to £1100 per annum, together with F.S.S.U. benefits and family allowance. In the case of an overseas applicant, the University is also prepared to consider the provision of an allowance towards defraying the cost of travel to and from Great Britain. Forms of application and further particulars may be obtained from the undersigned.

Applications (two copies) should be submitted not later than 16th FEBRUARY, 1961.

CHARLES H. STEWART,
Secretary to the University.

December, 1960. D 671

SUPERINTENDENT ENGINEER

SUPERINTENDENT ENGINEER required by the EAST RIDING HOSPITAL MANAGEMENT COMMITTEE. Successful candidate will be responsible for the maintenance and operation of steam generating plant, electrical mechanical engineering services and heating systems, and should possess an Engineering degree; A.M.I.Mech.E. or equivalent qualification. Knowledge of minor road repairs and sewage work operation an advantage. Salary £1070 by £30 (2) by £35 (3) to £1235.

Detailed applications giving two referees to GROUP SECRETARY, WESTWOOD HOSPITAL, BEVERLEY, YORKSHIRE. D 632

VANDERVELL PRODUCTS LIMITED

Western Avenue, Acton, W.3

have vacancies in their Drawing Office for

EXPERIENCED DESIGN DRAUGHTSMEN

and offer permanent staff positions with good commencing salaries, pension rights, life assurance, etc.

Applications are invited from young men, preferably apprentice trained and with experience in the light engineering industry and in particular on special purpose automatic machines. Candidates with Ordinary National Certificate will be considered but preference will be given to those who have qualified at the Higher National Certificate level. Some knowledge of automobile components, whilst not essential, will be of advantage.

Write brief details of age, experience, etc., in first instance to the PERSONNEL MANAGER. D 634

MOBBS & LEWIS LTD.

WOOD LAST MANUFACTURERS

CARRINGTON STREET

KETTERING

Applications are invited for position of QUALIFIED DEVELOPMENT AND MAINTENANCE ENGINEER, eventually to be in complete charge of modern engineering department serving three woodworking factories. A knowledge of hydraulics, compressed air tools and power would be highly desirable. Applicant's qualifications should include preferably University degree, but at the least H.N.C. in Mechanical Engineering or equivalent City and Guilds Certificate with a high standard of school educational achievement. Position eligible for pension scheme, and successful applicant will be directly responsible to the Directors.

Applications to MR. H. E. B. BUTLIN, MANAGING DIRECTOR. D 670

CENTRAL ELECTRICITY GENERATING BOARD
ASSISTANT ENGINEER
ELECTRICAL PLANT

required in the POWER PLANT DESIGN BRANCH. The Branch is responsible for the design of boiler, turbo-generator and ancillary plant in conventional power stations, and for the design of plant other than reactors and their ancillaries in nuclear power stations. It is staffed mainly with engineers specialising in individual items of power plant, or in particular aspects of those items, and works in close collaboration with those responsible for the operation of the Board's power stations.

Duties will be to assist in analytical and technical investigations into design problems associated with rotating electrical plant for installation in power stations.

Candidates should have a degree in electrical engineering and/or corporate membership of the I.E.E., with a sound knowledge of the principles of electrical machine design and some manufacturing and test experience with large alternating current rotating machines.

Salary within the range £1460-£1990 per annum.

Applications stating age, qualifications, experience, present position and salary, should be forwarded to the PERSONNEL OFFICER, 24/30, HOLBORN, LONDON, E.C.1, by 16th January. Envelopes should be marked "Confidential Ref. ENG/435."

D 641

DRAUGHTSMEN

Draughtsmen required for permanent, pensionable positions. Technical qualifications H.N.C. or O.N.C. in mechanical engineering. Sound knowledge of gearing design desirable. Please give full details of experience, qualifications and salary required.

Applications, which will be treated with the utmost confidence, should be addressed to:—

The Technical Director,
OPPERMAN GEARS LIMITED,
Newbury, Berkshire

D 658

FEDERAL GOVERNMENT OF NIGERIA

SCIENTIFIC OFFICER

(GEOPHYSICIST)

The Geological Survey Division of the Federal Ministry of Mines and Power have vacancies for Scientific Officers (Geophysicist) to conduct geophysical surveys using a.c. and d.c. resistivity apparatus, d.c. potential equipment, vertical forces magnetic variometer, shallow seismic gear, and equipment for logging resistivities and temperature gradients in boreholes.

Candidates must hold a good honours degree in Geophysics, Physics, or Engineering. Alternatively, a good honours degree in Geology, with Physics or applied Mathematics as subsidiary subjects. Experience in applied Geophysics, and some knowledge of Electrical Circuitry and an ability to maintain apparatus will be added advantages. Candidates should preferably not be over 35 years of age.

Contract: appointment for one tour of 15-18 months in the first instance with prospect of extension. Salary according to qualifications and experience £1434-£2196 per annum (including inducement addition) plus gratuity of £100-£150 on satisfactory completion of service. Outfit allowance of £60 payable for salaries not exceeding £1740. Free passages for officer and wife. Liberal home leave on full pay. Quarters and income tax at low local rates. Children's allowances while separated.

Write for application forms and further particulars, stating briefly age, qualifications and experience, to the APPOINTMENTS SECRETARY, FEDERAL PUBLIC SERVICE COMMISSION, NIGERIA HOUSE, 9 NORTHUMBERLAND AVENUE, LONDON, W.C.2, quoting J.3/9. D 669

LAPORTE CHEMICALS LIMITED

(a member of the Laporte Group of Companies)

require

SECTION LEADERS

for interesting work on large chemical plant installations. Candidates, aged between 30 and 40 years, should be experienced in plant layout and vessel design and familiar with British and American Codes of Practice. They should be first class men of H.N.C. Standard, capable of controlling a section of draughtsmen and working under the direction of a Project Engineer.

The positions are permanent and attractive salaries will be offered to the selected applicants. Modern offices situated in the London E.C.4 area. Five-day week and superannuation scheme. Applications will be treated in the strictest confidence.

Details of age, qualifications and experience, and quoting reference LCL/E2/82 should be sent to the Group Personnel Manager, **LAPORTE INDUSTRIES LIMITED**, Hanover House, 14, Hanover Square, London, W.1. D 625

APPOINTMENTS OPEN

SENIOR DESIGN DRAUGHTSMAN

SENIOR DESIGN DRAUGHTSMAN required. Must be fully experienced in Hydraulic Engineering and general engineering design. State experience and salary required. Pension scheme and canteen facilities available.—Apply by letter marked: TECHNICAL MANAGER, THE HYDRAULIC ENGINEERING CO., LTD., CHESTER. D 651

FUEL TECHNOLOGIST

FUEL TECHNOLOGIST required by the National Coal Board, Divisional Marketing Department, Edinburgh. Salary within the scale £1300 to £1825 per annum. The successful candidate will advise on and deal with technical matters relating to the use of coal or coke in boilers, furnaces, etc. Membership of the Institute of Fuel or similar qualifications, together with considerable experience, an advantage. —Applications stating age, education, qualifications, experience, present post and salary, to STAFF DEPARTMENT, NATIONAL COAL BOARD, 3 EGLINTON CRESCENT, EDINBURGH 12. D 645

CIVIL ENGINEERING ASSISTANT

CIVIL ENGINEERING ASSISTANT required in the London Office of Norman & Dawbarn, Architects and Consulting Engineers, for Civil Engineering work associated with various building projects including airports and factories. Age preferably between 25 and 35. Written applications must give age, experience, qualifications and salary required, to: NORMAN & DAWBARN, 7, PORTLAND PLACE, LONDON, W.1. D 617

ESTIMATOR AND RATE FIXER

EXPERIENCED ESTIMATOR and RATE FIXER required for Machine Shop Planning Department. Preferably with knowledge of Work Study.

Apply giving age, experience, and salary required to:—

PERSONNEL MANAGER
KENT ALLOYS LIMITED
TEMPLE MANOR WORKS
STROOD, ROCHESTER, KENT

D 636

CHARTERED ELECTRICAL ENGINEER

A vacancy exists for a chartered electrical engineer with an Hydro-Electric Power undertaking in Northern Nigeria. Pleasant climate, 4000 ft. above sea level. Age 30 to 35. Salary grade £1335/£1565 according to age, qualification and experience. Pension and Life Assurance Scheme. Eighteen months tours with three months' leave on full salary. Free furnished quarters. Free passages self, wife and two children, or equivalent benefits if children remain at home.—Write BOX E.996, c/o STREET'S, 110 OLD BROAD STREET, E.C.2. D 594

ENGINEER

QUALIFIED ENGINEER required with drive and ability to take position of responsibility in company engaged in wide variety of small plant projects. Near Brighton.—BOX D 672, Offices of ENGINEERING.

THE GLACIER METAL COMPANY LTD.

Manufacturers of Plain Bearings

have a vacancy in their Licensing Department for an

ASSISTANT LICENSING ENGINEER

The Licensing Department is concerned with the liaison with overseas manufacturers who are licensed to use Glacier manufacturing processes and techniques.

The A.L.E.'s work will be concerned with providing licensees with data on the Company's manufacturing processes, interpreting licensees' requirements, showing visitors around the factories, explaining techniques and processes, etc.

Applicants must have a sound engineering knowledge of at least H.N.C. standard and previous experience in the field of production engineering. Alternatively, a young graduate mechanical engineer with one or two years' industrial experience might fit in this role.

Candidates must be able to speak and write clear, concise English; knowledge of French and/or German would be an asset but is not essential.

Minimum age 25 years. The salary is in the range of £950 to £1350 per annum. Send brief, relevant details, quoting Ref. HQPD/ALE, to:—

PERSONNEL DIVISION
THE GLACIER METAL CO., LTD.
ALPERTON, WEMBLEY, MIDDX.

D 648

BIRDS EYE FOODS LIMITED

GREAT YARMOUTH

have the following vacancy:—

LAYOUT ENGINEER GDS/15

The selected candidate will be responsible to the Factory Chief Engineer for the efficient operation of the Drawing Office. His duties will include process plant and packaging equipment layouts and preparation of installation costs. The position entails an amount of design work.

Previous applicants are being considered and need not re-apply.

Written applications from qualified men with experience in this field should be addressed to the

PERSONNEL MANAGER
BIRDS EYE FOODS LIMITED
SOUTH DENES
GREAT YARMOUTH D 644

COMPANY MEETINGS

J. BROCKHOUSE & CO.

Substantially Increased Profits

Mr. J. L. Brockhouse on Policy of Expansion

The 63rd annual general meeting of J. Brockhouse & Company Limited was held on December 21 at West Bromwich, MR. J. L. BROCKHOUSE, M.A. (Chairman and Managing Director) presiding.

The following is an extract from his circulated statement:

It is pleasing to be able to report a substantial increase in profits for the financial year ending 30th September last. This is in part a reflection of the increased activity of the General Engineering Trade during the period, and in part a measure of the progress of the technical and productive capacity of the Organisation.

During the year we made an offer for all the outstanding shares in the Albion Drop Forgings Company, Limited, of Coventry, which was accepted by the necessary majority, and the Company is now a wholly owned Subsidiary. It has not, however, contributed to the profits of the Group this year, but will in the future prove a valuable asset, when the Company can enjoy the full benefits of the re-organisation and re-equipment at present taking place.

The offer we made to the outside Ordinary Shareholders in J. Brockhouse (South Africa) Limited was accepted, and your Company now owns all the equity in this Subsidiary. The profits for the year were smaller than anticipated, but I have no doubt of the more long term prospects.

Both the manufacturing companies in the Rhodesias made losses, and until the political situation in the Federation is clearer, it is unlikely that conditions will improve.

Our Subsidiary Companies in the United States of America and Canada made satisfactory profits, and look forward to continued expansion.

Development and Expansion

In most of the manufacturing plants at home, we have embarked upon programmes of development and expansion, and you will see on the Balance Sheet that outstanding commitments for Capital Expenditure are £430,000, in addition to which during the year we have spent £752,000, the bulk of which is for this purpose.

Our present policy is to finance these developments out of our own resources, and to limit our expenditure to the extent that we are able to do this, and if necessary to provide for the fluctuations in Stock and Debtors by temporary borrowings.

The necessity of this expansion is generated by two factors, the first is to provide more modern equipment to enable us to remain competitive and the second is to keep pace with growing demands from our customers. We must also develop new or improved products in our own line of business.

The Outlook

At the present time we are witnessing a serious fall off in the Automobile Trade and it is impossible to forecast how long this trend will last. There is, however, no doubt of the steady growth of this Trade over a longer period, and I believe that we have to accept these temporary fluctuations in volume as part of a bigger picture of expansion.

How far this present trend will affect your Company next year is very difficult to forecast. At the present moment the General Engineering Trade, which is the major portion of our activity, is very busy, but a falling demand in one section is bound to influence the rest sooner or later, and with this in mind it would be unrealistic to expect any substantial improvement in profits in 1961, but unless this temporary phase is more severe than I anticipate, we should continue to enjoy a reasonable return.

It is of course necessary to plan for some years ahead, and both my Colleagues and myself have every confidence that your Company will continue to grow with general industrial development.

The Report and Accounts were adopted. D 642

HEENAN GROUP

Continued Expansion

The 58th Annual General Meeting of Heenan Group Limited was held on December 19 at Worcester. Mr. Charles L. Hill, the chairman, presiding.

The following is a summary of his circulated statement:—

The Group net profit, before taxation, of £564,387, exceeds the record achieved last year of £521,469. After providing for taxation, which takes £281,639 against £262,589, the net profit of the Group is £282,748 compared with £258,880.

The whole of the share capital of Armstrong, Stevens & Son Ltd., of Willenhall and Birmingham, was acquired during the year. The accounts do not include a full year's earnings of this new subsidiary.

The Group order position is most satisfactory with a balance of orders outstanding at the close of the year of £4,400,000. Orders received during the year from home and overseas exceeded £6,000,000. The subsidiaries are well represented abroad but the support of directors and executives is often necessary; on average two overseas visits have been made every week covering all Europe, Russia, the Middle East, North and South Africa, North and South America, India and Pakistan.

REVIEW OF COMPANIES

Heenan and Froude Limited has had an active year with demand for most of its specialised manufactures at a high level and with production limited only by the shortage of skilled men.

Engine Test Plant: an important advance has been made in the field of hydraulic dynamometers after three years of development. Known as the P.T. Dynamometer, the first production model has been installed at London Airport for B.E.A. Jet engine test plant for Conway engines has been supplied to Rolls-Royce Ltd., another of very modern design to Aerolineas Argentinas. High-speed Froude Dynamometers have been exported to Europe with ratings as high as 10,000 h.p. at 10,000 r.p.m. and a new type of Roller Car Tester built.

Eddy-Current Couplings: sales rose to a new record level and these couplings are being constantly applied to new industries finding useful applications for this speciality.

Industrial Coolers: sales were up by a third on the previous year.

Automatic Wire and Strip Forming Machines: sales remained steady at the previous year's level.

Municipal Engineering: Several contracts are in hand and a number of promising projects are under consideration.

Fielding and Platt Limited ended the year with a good order book, the bulk of current contracts being for delivery within 12 months. The prospects for maintaining a satisfactory order book appear reasonably good. Two large presses have been delivered and a complete hydraulic power installation despatched to the Durgapur Steel Works. An entirely new design of self-contained extrusion press has been delivered to the Midlands and a large order received for three extrusion presses for Switzerland.

Court Works Limited, specialists in malleable iron and grey iron casting, has well maintained its output and sales. An additional mechanised foundry is being built for the production of pearlitic and blackheart malleable castings.

Morton Machine Co., Ltd., had a satisfactory year's trading. The order book position is very healthy and prospects for the coming year encouraging.

Iwel Engineering Limited increased its sales of Abattoir and Animal By-Product equipment and orders received were up by over a third, nearly half of the total being for export.

The order books of **Armstrong, Stevens and Son Ltd.** have been considerably improved since the acquisition of this new subsidiary in January.

Associated Locomotive Equipment Ltd. continues to experience difficult trading conditions and its future depends upon new products outside the railway field.

The report was adopted and a final dividend of 8 per cent. on the increased ordinary capital was approved. D 643

Companies

ICI's Reshuffle and Soviet Trade Prospects

IMPERIAL CHEMICAL INDUSTRIES' rearrangement of executive directors' responsibilities and regrouping of manufacturing divisions is to take effect from 1 January.

At the board level research and development have been combined. ICI's functional directors will now be those of Finance, Commerce, Technical, Research and Development, Personnel, Overseas—Western Hemisphere and Africa south of 15° North, Overseas—Europe excluding Russia and Eastern Europe, and Overseas—Rest of the world.

The regrouped manufacturing divisions will be Group A, alkali and general chemicals, Group B, dyestuffs, paints and pharmaceuticals, Group C, fibres, heavy organic chemicals and plastics, Group D, Billingham and Nobel divisions, Wilton and Severnside works, and Group E, metals division.

Far away from organisational reshuffles, Mr. S. Paul Chambers, the ICI chairman, has been in Moscow, expressing the hope that the company's trade with the Soviet Union would double, or perhaps even increase fourfold, in the next few years.

Negotiations are to open for the purchase by ICI of a Russian licence for the manufacture of caprolactam, a raw material used in the production of nylon. A cheaper method of making caprolactam exists in Russia. Talks are already going on for ICI to sell plant in the Soviet Union for polyethylene manufacture.

Increasing Orders for Lifting Machinery

The higher level of orders during the last financial year, were not able to prevent the HERBERT MORRIS Company, who produce transporting and lifting machinery, from suffering a severe reduction in the trading profits.

Despite the pick up in orders, the influence of the earlier slowness in demand produced a situation in which the company was not operating at an economic level for several months of the past year. Sharp competition both at home and overseas considerably reduced the profit margins.

Rather more cheerful prospects for the future are indicated by Mr. Frank Morris, the chairman, who reports that since the close of the financial year there has been a continued increase in the rate of new orders. If the trend continues an improvement in the results for the current year is a reasonable expectation.

Looking round the overseas subsidiaries, Mr. Morris sees further difficulties. Slowing down in industrial expansion in Canada has severely affected the production of the company there. It was not possible to make full use of the additional manufacturing capacity made available at the Niagara Falls plant.

Although the conditions in South Africa gave cause for concern and affected output, the Transvaal subsidiary operated with unimpaired profitability and the current year is expected to show an improvement.

Demand for mechanical handling equipment remained comparatively high in Australia and expansion of the activities of the subsidiary there are expected although the competitive conditions in Australian trade make for tough going.

Electronics at Home by Eurelec

Anyone who has tried to get a radio or television set repaired knows that skilled technicians are about as scarce as astronomers or coachmen. One of the biggest French manufacturing companies in this field, COMPAGNIE GÉNÉRALE DE CSF (known by the initials CSF) has faced up to this problem in an interesting and unusual way. Eighteen months ago CSF set up a correspondence college, L'INSTITUT EUROPÉEN D'ELECTRONIQUE, or EURELEC for short, to teach electronics to potential service technicians. The results have been extremely encouraging and already over 20,000 students have been enrolled at a fee of 700 NF each. The first object is to turn out men capable of working as fitters and repair men. But for those who show especial aptitude there is a further course which will lead on to higher qualifications.

The EURELEC courses require a considerable amount of practical work by the students. How is this done by correspondence? EURELEC claims to have found a simple and effective answer to this problem. Students receive by post spare parts which they learn to assemble. As a result by the end of the course they have accumulated a set of tools and have built a whole range of sets. All told the EURELEC syllabus covers some 42 subject groups. The courses follow normal academic terms and students are allowed to spread payment of their fees over the year. EURELEC benefits considerably from its connection with CSF. To keep track of its students EURELEC has installed an elaborate punched-card system, and makes use of the CSF Research Centre at Puteaux for help with the practical work.

With the CSF Italian subsidiary Radio Elettra, two new ventures are being started in the new year. These will be EURAL-ALLEMAGNE at Cologne and EURELEC-BENELUX at Brussels. In short it looks as though EURELEC is now out of the experimental stage and is a commercial as well as educational success.

50-50 Kuwait Offshore Agreement with Shell

The SHELL INTERNATIONAL PETROLEUM Company and the authorities in Kuwait have concluded an agreement for offshore exploration and production. A substantial initial bonus for the right to explore and develop has been paid and the basis of the agreement is on what Shell International call a "mutually beneficial" fifty-fifty financial agreement.

Lively and keen competition was encountered by Shell International part of the ROYAL DUTCH/SHELL GROUP which now looks forward to welcoming Kuwait interests to the exploration and development if it is desired by the Kuwaitis.

New Steel Firm in Firth Cleveland Group

The FIRTH CLEVELAND GROUP have formed a new company—FIRTH CLEVELAND STEEL Limited—whose function will be to provide close technical, administrative and sales cooperation for three established firms in the group.

They are J. J. HABERSHON AND SONS, the TENUOUS STEEL Company and FIRTH CLEVELAND STEEL STRIP. Between them the three companies make a varied range of specialist steel strip.

The chairman of the new company will be Mr. C. W. Hayward (inset), the FC chairman. The company will operate from Rotherham, Yorks, and will have Mr. John Tonking as managing director.

Mr. Tonking has explained: "Orders placed with Habersons, Tenuous and Firth Cleveland Steel Strip will continue to be executed by these three companies as separate manufacturing firms and there will be no break in the continuity of association between customers and the individual companies concerned."

All the area sales managers and sales representatives of the three companies have been transferred to Firth Cleveland Steel and they will book orders for and maintain daily contact with each of the three.

Habershons specialise in rolling stainless, carbon and mild qualities of hot and cold rolled steel strip. Firth Cleveland Steel strip activities are concentrated on hardening, tempering and cold rolling of spring steel strip, especially in wide widths.

Tenuous Steel are widely known for their hardened and tempered steel strip in narrow widths.

Nigerian Air Survey by British Company

A British aerial survey company has been awarded one of the first contracts to be handed out by the Government of Nigeria in that country's first weeks of independence.

The company is FAIREY AIR SURVEYS Limited, a member of the FAIREY GROUP The survey subsidiary has its own subsidiaries and associated companies in Canada, India, Pakistan and the Rhodesias.

The Nigerian contract provides for an aerial photographic programme of about 25,000 square miles in the three regions of federal Nigeria. The maps produced will be used in the programme for the economic development of Nigeria.

Based originally at Lagos, and subsequently on provincial centres, the survey will keep one aircraft and a survey team busy for six months. Weather conditions are not particularly helpful. For most of one half of the year the wet Atlantic winds build up heavy layers of low cloud and in the summer the Harmattan, the prevailing wind, blows sand southwards from the Sahara.

New Glass Company by AEI and GEC

ASSOCIATED ELECTRICAL INDUSTRIES' LAMP AND LIGHTING Company's glass works in Chesterfield and the GENERAL ELECTRIC COMPANY'S Lemington-on-Tyne and Wembley factories will come under the control of a new AEI-GEC glass manufacture and glass sales company. The new firm is expected to come into existence early next year.

Fourteen years ago the two electrical heavyweights combined to set up GLASS BULBS, a company which enabled the market for popular sizes of electric lamp bulbs to be more economically catered for. The new concern will take over all glass manufacture for both groups, without in any way affecting the existing Glass Bulb company.

It is at present anticipated that the glass tubing facilities at Chesterfield will be increased and that Lemington will be developed as a glass hand fabricating works.

Although some redundancy may follow, this is not expected to arise before 1962 and a promise has been made that efforts will be made to find suitable employment within the two companies for displaced staff or workpeople.

Admiralty Research and Nuclear Investigation

An important part of the activities of the YARROW AND COMPANY shipbuilding and engineering concern is their cooperation with the Royal Navy through the YARROW-ADMIRALTY RESEARCH DEPARTMENT. Set up in 1947 the Department has been very active for some years and has programmes which will keep it so for years ahead.

A substantial proportion of the Department's staff are concerned with investigating the application of nuclear power to surface ships. Along more conventional lines, the services of the Department were enlisted by the Chandos Committee when they were preparing their report on the replacement for Cunard of the Queen liners.

In the past financial year HMS Rothesay was delivered to the Admiralty and work on a number of frigates is going on satisfactorily. The SAS Kreuger has been launched for the South African Navy. Sir Harold E. Yarrow, the chairman reports in his annual review that a high class diesel yacht has recently been received.

The South African subsidiary and the land boiler department have been "reasonably busy."

Although few orders were received in any of the production departments in the past year, the volume of work in hand will provide a reasonable level of work throughout the current year. While all the Yarrow company's products are in keenly competitive fields, their range is through a wide variety of engineering work, which is a measure of guarantee for all round performance in the future.

Perkins Outboard Motors

A marriage between American design and British manufacturing technique has successfully launched the large outboard motor in this country.

FROM a pleasure-giving luxury the motor car has become a social necessity—so it is only natural that for pleasure we should turn to boating. If recent happenings across the Atlantic can be taken as a guide, the next few years will see a further upsurge in the inexpensive kind of boating that the outboard motor provides.

How are the outboard motor manufacturers dealing with this situation? So far as American firms are concerned, they produce their established models in quantity, generally with slight changes in style each year to keep up with modern fashion trends. These may be regarded as luxury models and, being imported, they are fairly expensive to buy over here.

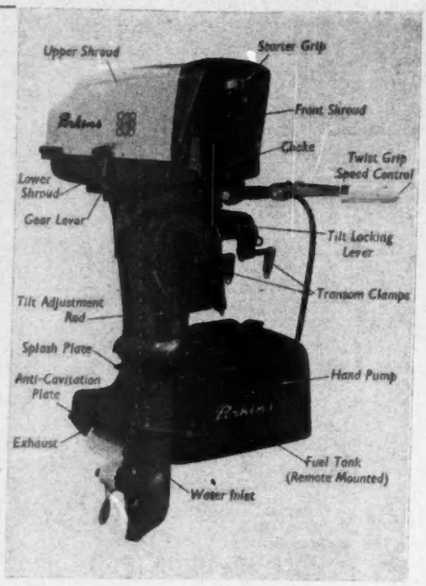
British manufacturers mostly prefer to concentrate on generally smaller, but simple, rugged and inexpensive machines without "frills"—in fact all except one. The exception is F. Perkins Limited of Peterborough, well known for their success with lightweight diesel engines, who in 1959 started manufacturing American style outboards in this country for the first time. The selling price immediately undercut comparable American-built engines, both in Britain and abroad; yet the established high quality of manufacture was, if anything, improved. This venture was an immediate success.

The outboard motor market is in a class by itself. Selling is largely seasonal, and the seasons vary greatly from country to country. Furthermore the great majority of engines are used many miles from where they were bought. The outboard motor spends very nearly all its life idle or in storage at the owner's home. At weekends or holidays it is taken on a lengthy journey to a stretch of water probably in the boot of a car, and is then expected to start immediately and work perfectly. It may even be left in water or lying on a beach for a time between spells of running. However good the design no engine will stand this treatment for long, and the attentions of a service station will be required at the waterside during the holiday season. Winter overhauls, on the other hand, will probably be done by the dealer near home.

These factors combine to make the setting up of a distributive, spares and service organisation extremely difficult. And yet Perkins knew that if they were to succeed, the problem must be tackled. Their solution was to form a new subsidiary company to take care of all sales and service matters, and at the same time to build up a spares and service organisation second to none in the marine engine field. Perkins now sell outboards all over the world, and encourage their dealers to send mechanics to their school and hence take on service responsibility.

Diversification of products in this instance was a "breakthrough" into something quite new; but where existing "know-how" could be utilised. The product chosen filled a large gap in an existing market—a gap that was not obvious and could only be revealed by intensive study of the market and accurate forecasting.

The large American outboards are a direct result of American economic and social conditions. Most manufacturers produce models as large as 75 to 80 h.p. at the upper end of the range. Compare this with the modest 4/5 h.p. that used to be the largest made in any quantity in Britain. This disparity is explained partly by deliberate sales policy and partly by the difference in uses found for outboards in America. Water ski-ing, for instance, has become a popular sport, for which a motor of 16 h.p. or over is desirable. Also the outboard has been generally accepted for use in coastal waters to a greater extent than in Britain. The large-motor tendency has grown a lot in the past ten years; for example, in 1950 15 h.p. motors and over represented less than 10 per cent of the total American outboard market, but by 1960 this proportion had risen to over 60 per cent.



PERKINS OUTBOARDS

One of the American outboard manufacturers was the Oliver Corporation, well known agricultural machinery manufacturers, who started making outboards about 1955 at Battle Creek, Michigan. By 1958 Oliver were turning out three sizes of 6, 16 and 35 h.p. In the meantime F. Perkins Limited in England had formed a division to introduce new products into their organisation. The first result was that in December, 1958, agreement was concluded with Oliver for the purchase of sole manufacturing rights of their outboards, together with a quantity of special machine tools and motor components, for about £1 million.

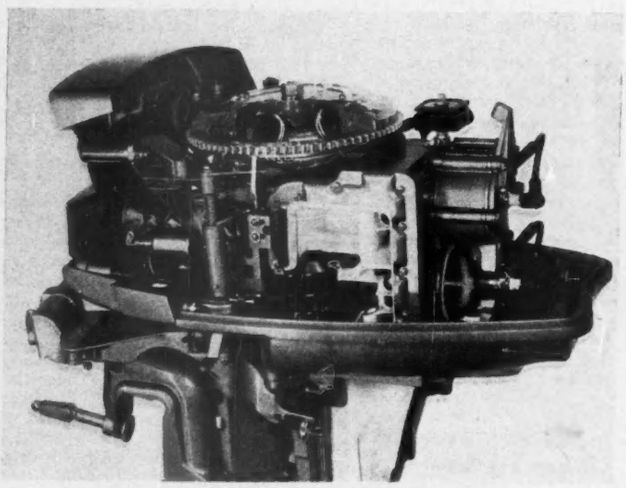


Fig. 1 (top) General view of the 16 h.p. All motors are designed for local or remote control, but tiller steering is not offered with the 40 h.p. Outboards may be ganged together in pairs if required.

Fig. 2 Cutaway of power head of the 35 h.p.

Fig. 3 (bottom) Cutaway of lower unit of the 35 h.p. Gear change is by sliding yoke on splined portion of shaft between top and bottom bevel wheels.

The next step was for F. Perkins Limited to form a new subsidiary in January, 1959, Perkins Outboard Motors Limited, for marketing and servicing the new outboards through a chain of dealers. A month later F. Perkins became part of the Massey-Ferguson group of companies.

Having taken on the job of building the new outboards, F. Perkins acquired the 150,000 sq. ft Walton factory, near Peterborough. Work started at Walton about September, 1959, and the factory now employs nearly 500 people mainly on outboards. Production capacity is about 150 per eight-hour shift.

TECHNICAL PARTICULARS

A multi-cylinder arrangement, the extensive use of pressure die-castings, a petrol tank remotely mounted on the boat and total enclosure of the engine in a styled cowl are all typical

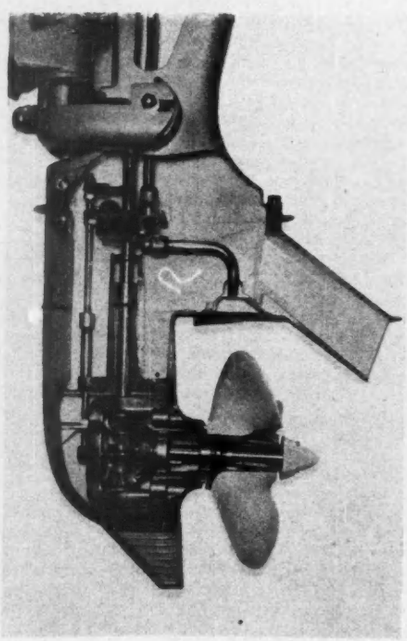


Fig. 4 A case where an American conception proves to be acceptable in the United Kingdom.

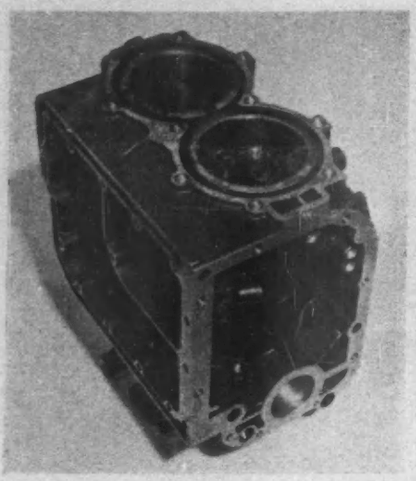
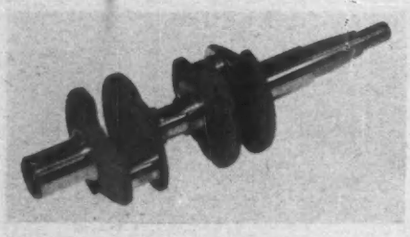


Fig. 5 Machined cylinder block of the 35 h.p.

Fig. 6 Crankshaft of the 16 h.p.



American features. Apart from the advantages of the cowl in terms of engine protection and quietness, Perkins have found that styling is a factor of paramount importance in the success of any outboard motor.

The power head comprises a water-cooled 2-cylinder 2-stroke petrol engine. Tabulated particulars of the four motors in the present range are given. The 6, 16 and 35 h.p. correspond with the Oliver range, while the 40 h.p. has just been announced. Forward neutral and reverse gears are provided, the cable-operated gear change being interconnected with the throttle. This ensures that gear changing is not attempted unless the motor is idling. Manual starting is of the automatic rewind type. The cam-operated poppet valves on the 35 and 40 h.p. reduce the pressure loss inherent in reed valves and improve acceleration at low speeds.

The transmission consists of a vertical drive shaft directly coupled to the crankshaft and carrying an arrangement of bevel gears in an oil-filled section at the lower end driving the propeller. A choice of propellers is offered.

The drive shaft housing consists of a streamlined one-piece aluminium die-casting. All models are supplied in either short or long shaft versions. The latter have a 5 in extension to the lower unit, and are provided according to crafts' stern transom height.

For the electrical equipment Perkins are still to a large extent dependent upon the United States. Ignition is by flywheel magneto manufactured by Bendix's Scintilla Division. In the case of the 35 and 40 h.p. the magneto alternator is specially designed for outboard motors, and supplies current for the sparking plugs and also for charging the battery, when provided. The carburettor is also American, being a Tillotson concentric bowl type to suit wide angles of tilt, with adjustable jets.

SPECIAL PROBLEMS

The power-to-weight ratio of a modern large outboard power head is extremely high, in fact almost 1 lb per b.h.p. in the Perkins 40 h.p. The estimated running life between major overhauls is 300 to 500 hours, without taking into account the lengthy periods of storage which most engines will suffer. These figures suggest that a high standard of design and manufacture must be combined with extensive use of light alloys, and such is indeed the case.

Each motor is built up from aluminium pressure die-castings, of which the cylinder block of the 35 and 40 h.p. is perhaps the most outstanding, see Fig. 5. This process offers three big advantages over gravity castings:—

(1) The finished casting has a smooth and pleasing appearance, thus saving some machining.

(2) It is relatively cheap in quantity.

(3) Good homogeneity and accurate maintenance of dimensions gives the casting a better strength-to-weight characteristic.

To resist corrosion all castings are Bonderised.

The dies were originally brought over from America and distributed among casting suppliers, but some initial production delays were caused by the many modifications necessary to suit British manufacture. Delays with other components were also experienced due to Perkins' insistence on a very high standard of manufacture, for example, all the first 200 crankshafts delivered were rejected. To maintain this standard a rigid inspection procedure is in force.

The first step on acquiring Oliver's manufacturing rights was to test motors to destruction. The knowledge thus gained led to improvements in the first Perkins machines, and the process has continued until now a total of 17,000 hours of development running have been attained and over 900 modifications made to the three original designs. Among these were the introduction of fully instead of partly watercooled heads for the 35 and 40 h.p., and reshaping the combustion chamber and piston crown, thus improving distribution and cooling and hence lengthening plug life. Silencing has also been improved in stages, and the latest arrangement in the 35 and 40 h.p. reduces back pressure and gives increased power. Fumes and smell have been reduced by the use of needle roller bearings for big end and crankshaft in the 16, 35 and 40 h.p., which allows a reduction in the oil content of the fuel.

THE FUTURE

Before the large outboard motor can reach the same degree of public acceptance over here as in other parts of the world—there are now over 6 million in the United States alone—the noise problem has to be overcome and Perkins have made a significant contribution. Despite short-sightedness on the part of many local authorities, reflected in lack of proper launching facilities, etc., outboard sales in Britain have trebled in the past four years.

Another factor that Perkins are taking into account is the attitude of the boat builders, especially since the largest outboards lend themselves to workboats. In Essex, they have a stretch of water specifically for testing the behaviour of prototype craft with outboards, the aim being to introduce the boat-builder to the new concept of the large outboard. For the bigger sizes the boat should be designed to suit the outboard, rather than vice versa. Testing new craft is quite separate from the testing of engines, which is carried out initially in a test tank at Walton. Tests in England and West Africa prove performance under contrasting climatic conditions.

The success of the three basic Perkins models during 1960 suggests that before long the range of sizes may be increased in both directions. The smallest ones would then provide direct competition with established British outboards.

In the meantime Perkins are continually looking for ways of improving their present models. High on the priority list is making the engine itself less sensitive to moisture from direct swamping or condensation, mainly by individually waterproofing the electrics—and studying further ways to minimise noise, fumes and vibration. Perkins maintain that substantially undercutting the price of their American competitors is not enough—their outboard motors must also be better, right down to the last detail.

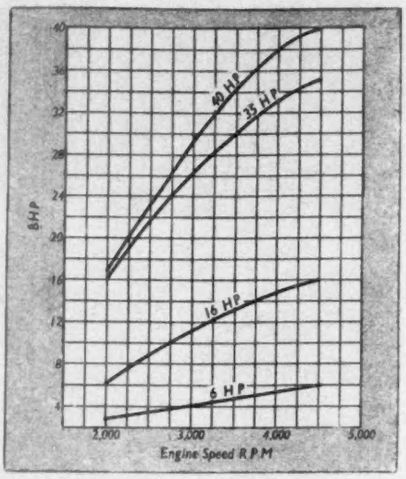
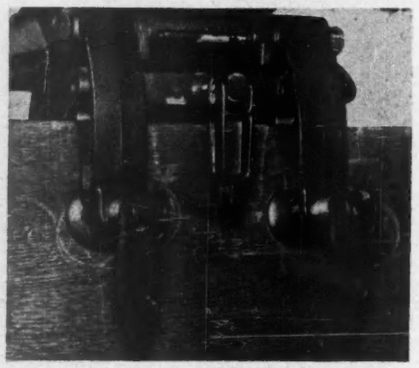


Fig. 7 Power curves.

Fig. 8 (below) Aluminium pressure die-castings are not confined to the major components.



H.P.	6	16	35	40
Bore × stroke (in)	2×1½	2⅜ × 2⅛	3 1/16 × 2⅜	3⅛ × 2⅜
Cubic capacity (c.c.)	154	325	690	722
Engine speed (r.p.m.)	4,500	4,500	4,500	4,500
Total weight* (lb)	50	75	127	130
Intake valves	Reed, 4 port	Reed, 6 port	Poppet	Poppet
Starting	Manual	Manual (electric optional extra)	Manual	Electric with emergency manual
Fuel tank capacity (gals)	2½	5½	5½	5½
Petrol/oil mixture	16 : 1	21 : 1	21 : 1	24 : 1
Exhaust	Underwater	Underwater	Underwater	Underwater
Propeller protection	Shear pin	Cushioned hub and shear pin	Cushioned hub and shear pin	Cushioned hub and shear pin
List price (UK)*	£82 10s 0d	£125 0s 0d	£180 0s 0d	£217 10s 0d

* Weights and prices quoted are for the basic short shaft version.

Diesels Bring Losses to USA Railways

Analysis of their record shows that diesels on USA railways have been costly to maintain and have a relatively short life, although operating costs are lower than for equivalent steam locomotives.

TODAY, after 20 years of operation of diesel locomotives on United States railways, it is possible to look back over their record and to compare what they have done with what they have been claimed to be able to do. This comparison has been undertaken in a paper, "Economic Results of Diesel Electric Motive Power on the Railways of the United States of America," by Mr. H. F. Brown. As stated in a previous issue (ENGNG., p. 497, 14 Oct. '60), the author casts serious doubts on the claim that diesels have made it possible to make operational savings of 30 per cent of their capital cost, after interest and depreciation charges. In fact, he suggests that, outside shunting service, the diesel has added to the financial burden of the railways.

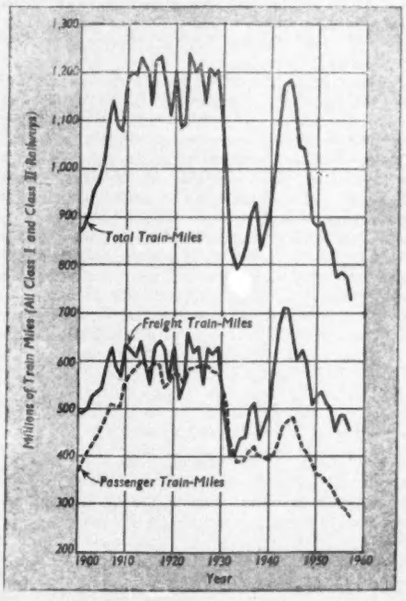


Fig. 1 Train-miles have decreased markedly since 1945 as branch lines have closed and short-haul traffic has been lost.

The diesel electric locomotive made its initial appearance on USA railways in yard service in 1925; but fewer than 100 such units were acquired during the next ten years. After the Second World War, the automotive industry started an active campaign to sell the diesel to the railways—at a time when steam locomotives were old and generally worn out.

The steam locomotive became outmoded almost immediately, by the testimony of its former manufacturers, who took up competition with the automotive industry in the manufacture of diesel power. About 8,000 diesel locomotives had been acquired prior to 1949. During the years 1949-52, more than 12,500 units were acquired; and, since 1952, about 7,000 more have been acquired up to the end of 1957. No steam locomotives have been built in the United States since 1952.

American manufacturers have not been able to build a single diesel unit having much more than 2,000 h.p., delivered to the rim of the driving wheels. Interstate Commerce Commission statistics for 1957 show that it required 2·08 diesel units per average passenger train, and 2·59 diesel units per average freight train. The average for all main line trains was 2·41 units. The tractive force of any of these combinations *at the running speed* is well within the capacity of most of the modern steam power remaining in either passenger or freight service in 1957. Thus more motive power units of the diesel type have been required to perform the present service than would have been required had modern steam locomotives been purchased in their stead. The actual number of diesel *locomotives* in main line service in 1957 was not the 18,959 diesel units given in statistical records, but this number was divided by 2·41, which is a total equivalent to 7,870 *Locmotives*.

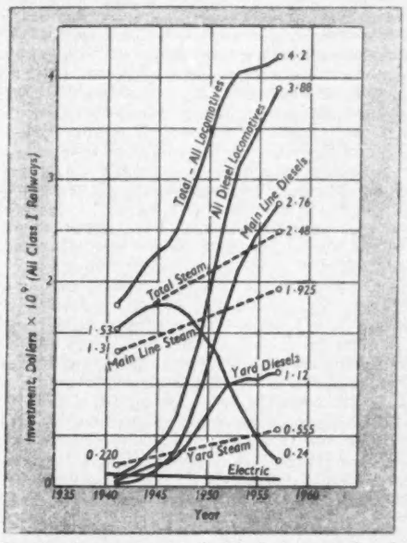


Fig. 2 Investment in diesels has risen sharply since 1945; the comparative costs of equivalent steam locomotives are shown by the dotted curves.

To establish a basis for comparison of operating costs and investment, Mr. Brown assumes that the number of modern steam locomotives equivalent to the main line diesel locomotives is inversely proportional to their availabilities. New diesel locomotives have an availability as high as 90 per cent. Modern steam power has an availability of at least 60 per cent when new. Then 7,870 times 1·5, or 11,800 steam locomotives, would be the hypothetical equivalent of the 18,959 diesel units in road service in 1957. The actual growth of investment in diesel locomotives and the estimated cost of the equivalent steam locomotives are shown in Fig. 2. Whatever advantages are gained in reduced operational costs clearly have to be compared with the much heavier investment costs of the diesel traction.

Mr. Brown pointed out that it is claimed that the large reduction in the number of trains as indicated by the reduction in train-miles since 1946 (Fig. 1) has been due to the multiple-unit operation of diesel locomotives, enabling the operation of longer and faster trains in both freight and passenger service. This in turn, it is said, has allowed a large reduction in the number of trains, thereby making large savings in operating labour.

However, if this were the case, the consolidation of two or more trains into one much longer train, with a reduction in the number of train miles, would call for an increase in the number of diesel units per locomotive nearly proportional to the reduction in number of train miles. During the period 1953-57 freight train miles decreased 10 per cent, gross tons per train increased 12·3 per cent, and units per locomotive only 5·3 per cent. In passenger service, train-miles (locomotive propelled) decreased 23 per cent, but units per locomotive increased only by 3 per cent. It is quite obvious, states Mr. Brown, that the increase in tons per train and the decrease in train miles is due to the withdrawal of many short trains on branch lines and to loss of the short haul traffic on the remaining lines, and the entire claim for the diesel is invalid.

The diesel also cannot be held responsible for the slight increase in average speed that has occurred over the period. It is probable that the increase is due to the elimination of slower trains and intermediate stops, together with improved dispatching and signal systems.

Turning to the question of repair costs, Mr. Brown stated that the rise in repair costs with age for diesel locomotives is often debated and denied on the basis that after "heavy repairs" the running costs drop to former low levels. When the costs of such repairs are spread over the intervening period, however, the total costs of repairs will be found to rise continuously with age. In Fig. 3 comparative repair costs in cents

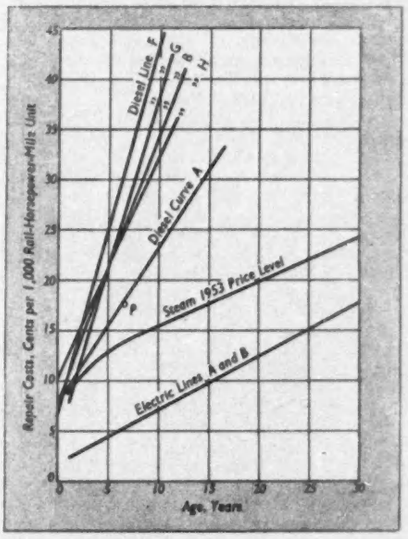


Fig. 3 Experience has shown that diesel maintenance costs increase steadily with age.

per 1,000 rail-hp-miles are shown for main-line steam, diesel, and electric locomotives.

Summing up, he points out that diesel locomotives as a whole made operating savings of $137 million compared with the assumed equivalent steam operation, on the basis of 1957 costs. For each year prior to 1957 the savings would have been less. This compares with a total investment $1,800 million greater for diesels and fixed charges $165·5 million greater than for equivalent steam locomotive investment.

Quite obviously, the savings realised by diesel operation in shunting service have not been realised in main line operation. Nothing can be found in Mr. Brown's analysis to justify the claim that diesels are producing a 30 per cent return on their investment. The companies operating the diesels are private enterprise concerns operated primarily for a profit. Earnings are closely related to traffic. The increase in dividends since 1940 does coincide with the change in type of motive power. But to relate these two facts is wholly unwarranted, declares Mr. Brown. Earnings for this period are lower, with more traffic, than during 1925-30, when all the motive power was steam and electric.

On the Shelf

By Frank H. Smith

AREN'T people funny on the telephone? There are all the stock phrases such as "I'm afraid." Just listen to people in the office and count the number of times they say "I'm afraid I cannot help you," or "I'm afraid he's not here at the moment." Then there are the people who ring me and start "I wonder if you can help me." This is usually followed by a pause, waiting, I suppose, for me to say "I'll try," but I don't and then the other person (usually a woman) gets panic-stricken and shouts "Are you there?" Sometimes, when I'm feeling generous, I'll say "I doubt it," whereupon the other end giggles and refuses to take any further conversation seriously. Another type I know prefaces every other remark with "sort of" *and* giggles between the sentences.

It is always interesting to hear of a new field being explored by the abstracting fraternity. *Internorm* is devoted to material on standards. For particulars apply to the editor, Dr. N. A. J. Voorhoeve, Eindhoven, 87 Parklaan.

A pretty wide range of physics and engineering seems to be covered by the publications of the State Institute for Technical Research, Helsinki. Such reports as I have seen are in separate form and I feel sure that the Institute will welcome inquiries and offers of exchanges from this country. They are not all in Finnish—many are in English—and with the batch of reports was a reprint from the VDI *Zeitschrift*.

I don't feel too happy about mentioning *Chemical Market Abstracts* but my arm is being twisted. There is no indication on the copy I have of how old it is, whether it's the 50th volume or the first, but it is certain that there have been 1,272 pages previous to those I am looking at. If you feel you'd find a place for these things and do not already have them, write to 29 West 15th Street, New York 11, and find out what you will get for $180 a year.

The 1959-60 version of the University of Cambridge's "Titles of Dissertations approved for the Ph.D., M.Sc., and M.Litt. Degrees" (Secretary of the Board of Research Studies, The Old School, Cambridge) has reached me and the usual crop of quaint titles is to be found therein. I do not think I will quote any of them this year as I have a sudden disinclination to showing how ignorant I am. (Must be the result of taking part in an Aslib brains trust, I suppose).

I apologise to Collet's Holdings but the last batch they sent to me was so large that it gave me indigestion. Three separate months of the booklet "What's new in Czechoslovak Science," a leaflet on five Russian periodicals with side-by-side English text, a list of new Russian books that I'd already had, a leaflet for a German translation from the Russian on the chemistry and technology of Zellstoffherstellung, whatever that is, and a sample of the Czech *Technical Digest* (in English). There—I've done it and now pass the bismuth. Incidentally, that last item isn't bad. £1 5*s* a year.

For some unfathomable reason the June copy of *Fairey Review* has only just crossed my sights (Fairey Company Limited, 24 Bruton Street, London, W1), which accounts for my failure to tell you of the loose insert "Table of elements, including all known isotopes," copies of which are available on application.

I do not know why it is, but I always enjoy the secondhand lists that look as though they have been badly typed on an old typewriter more than I do the tastefully printed ones in pukka covers. Perhaps it is because one feels there is a better chance of a bargain? Anyway, in this category (though on a respectable typewriter) is Thomas Barnard, The Bookshop, 209 High Street, Uxbridge. His list comes divided into aviation; railways; sea, ships and sailors; regimental histories; war and military. 392 items altogether.

Knack or Know-How?

Management in Britain. By I. C. MCGIVERING, D. G. J. MATTHEWS and W. H. SCOTT. *Liverpool University Press, 123 Grove Street, Liverpool 7.* (25*s*)

Management Survey. By SIR FREDERIC HOOPER. *Penguin Books.* (3*s* 6*d*)

McGivering, Matthews and Scott subtitle their book "A General Characterisation," and draw attention to its descriptive nature. Even if the approach that they have chosen does not produce any fireworks, no one can doubt its usefulness. Between the covers of this slim volume (only 150 pages) are the basic facts, both statistical and otherwise, which anyone needs to perceive the framework of ideas and economic organisation within which industrial management must operate in Britain today.

By deliberately adopting a somewhat pedestrian approach to their subjects, our three authors have introduced two important flaws into their work. It is difficult to be descriptive and non-controversial and at the same time not be dull. Moreover managers, management and industrial economics are subjects which abound in controversy so much that any attempt to be non-controversial about them is bound to misrepresent the balance of the subject to the reader. One can illustrate both these flaws by referring to McGivering, Matthews and Scott's discussion of the motivation of management. Economists, psychologists and sociologists have all had some intensely interesting things to say about it and even if the authors had merely *described* such differences of opinion as whether businessmen maximise profits, maximise turnover, minimise losses, or optimise several conflicting aims, they would have produced a more spicy, interesting and better balanced treatment. A minor irritant in a book which is avowedly descriptive is the important chapter on British industrial structure, where the statistics are manifestly out of date.

Nothing could provide a greater contrast and a better foil to the Liverpool volume than Sir Frederic Hooper's *Management Survey*. Written in a brisk style, full of stimulating if dogmatic generalisation and apt quotations, it is much more likely to set you digging for further information than the more comprehensive and academically sounder Liverpool volume. It is not a textbook but a personal testament from a man who knows his subject through living it and has loved every moment of the life. Every top-flight manager excels at something: one man may be a superb salesman, another a brilliant organiser of production and in Sir Frederick's case it seems that his forte has been his personal relations with the staff working under him. Throughout *Management Survey* runs a deep understanding of human beings in the everyday environment of industry.

On the other hand, Sir Frederick's approach has dangers which the reader should recognise. Generalisations lacking the cohesive force of a good theoretical structure behind them are inevitably often little more than wise old saws and can even be self-contradictory. Doubtless a good manager will have "influence or dominance, acceptability to others, the objective mind, solid commonsense, judgment, personality" and a "real zest for life and human contact," but these qualities would hasten success in many other fields of human endeavour from conducting an orchestra to conducting a 'bus. Elsewhere, "We know far too little about what makes men succeed in particular jobs at management level," but on an earlier page Sir Frederick says "Can the qualities which mark the born manager be stated? The answer on all accounts is undoubtedly 'Yes'."

Such inconsistency is far from trivial and indeed highlights the great difficulty of writing about the subject of management. Any manager of experience will soon sense when he is in the presence of a "born manager"; the trouble is we have no rationale to explain objectively how this act of recognition is performed. It is understandable that, given this lack of a theoretical background, Sir Frederick (the objective student of management thought as it exists at present) should sometimes get confused with Sir Frederick (the experienced practitioner) flying by the seat of his pants like the rest of us.

JOHN BRODRICK

Total Exposure

Surface Effects on Spacecraft Materials: 1st Symposium held at Palo Alto, California, May, 1959. Edited by FRANCIS J. CLAUSS. *John Wiley, New York and London.* (92*s*)

We are accustomed to remark on the satisfactory position of our Earth in the solar system and to note not only the stifling warmth of Venus and the arid cold of Mars—our next door neighbours among the planets—but also the suitable value of g which enables our globe, among other things, to retain an atmosphere. This envelope of gas, it is true, makes agriculture and respiration possible, both still very important even in our highly industrialised society, but it also protects us from the solar ultraviolet and X-radiation, from attack by the atomic hydrogen and protons of interplanetary space and from the constant bombardment of meteors and interplanetary dust which must pour as relentlessly down upon the surface of spacecraft as they do on the passive landscape of the Moon.

There may be few, especially among civil engineers, who would not have been glad at one time or another for a significant reduction in the value of g and the more fanciful may even have considered how their art would be affected were they to exercise it upon the Earth's own natural satellite. But the removal of gravity introduces more problems than it solves, as rocket engineers are well aware, and none is more severe than the elimination of the atmosphere.

Orbiting vehicles and deep space probes move in a peculiarly hostile environment. The absence of a blanket of gas subjects them to the full rigour of the solar spectrum, to a bombardment by neutral particles of both atomic and micrometeoric dimensions (diameters of a few microns). The energy of impact with a fast moving satellite lies for the former between a fraction of an electron volt for hydrogen and 11 eV for oxygen molecules, a range of energies spanning the work functions and bond energies of normal materials. Moreover, the particles may be the atomic alotrope of molecular gases such as hydrogen, nitrogen and oxygen and in this way may contribute to a surface reaction additional energy of a similar magnitude.

The meteoric particles may each contain about 10^{11} atoms. Of course far larger particles exist but their concentration probably falls as the fourth power of their radius so that impact with them is sufficiently rare to be neglected in the present state of the art. The micrometeorites travelling at velocities up to 30 km per sec can hardly fail to volatilise themselves and several times their own weight of surface material, so the problem of assessing the damage they do amounts primarily to that of determining their flux.

This quantity has proved surprisingly difficult to measure. In spite of very many attempts wide discrepancies exist, a fact which is rather surprisingly overlooked in Professor Beard's paper. The charged-particle environment of a space vehicle is even more varied than that due to the neutral components. Cosmic rays, though they may do serious damage to semiconductors, are

so penetrating that their surface effects may be neglected, and the protons and electrons of the Van Allen belts are not sufficiently concentrated to be an important factor affecting surface conditions. However the ion of the ionosphere must be considered. They may convey slightly more energy than their neutral counterpart as the ionisation potential normally exceeds the work function and in any case must space vehicles become negatively charged to a volt or so.

The vacuum of space may in itself constitute a hazard. Many lubricants, graphite for example, fail to operate in a vacuum and the absence of ambient gas removes a possibly useful means of neutralising the active radicals formed in many plastics by the action of ultraviolet light. Fatigue properties of metals may be changed either for better or worse by high vacuum and the behaviour of a microfracture can depend greatly on the nature of the ambient atmosphere.

Of course it is out of the question to simulate space conditions in the laboratory in all their varied aspects at one and the same time. Indeed it is difficult enough to approximate to them individually. Dust particles cannot yet be fired at meteoric velocities; an atmosphere of atomic oxygen cannot be maintained without introducing an electrical discharge at the same time, and even the solar spectrum cannot be simulated over more than a fraction of its active wavelength range from one source. Yet these are the objectives towards which techniques must be pressed as engineering in space assumes a role of increasing importance. In addition industrial vacuum technology will have to make big strides before anything like space vacuum is routinely achieved. At a pressure of 10^{-6} mm Hg. a clean gas free surface will be covered by a monolayer in a matter of seconds. An improvement of a factor of 10^{-4} is required before space conditions are approached.

Surface Effects on Spacecraft Materials is a good report of what must have been a very good conference. It is largely devoted to the measurement of emissivity, especially in the far infra-red, and absorptivity especially in the visible.

The ratio of these two quantities establishes the temperature of equilibrium of a spacecraft and it is their magnitude which determines the rapidity of response to environmental changes such as eclipse in the Earth's shadow. It is not surprising that such emphasis has been given to this aspect as the maintenance of satisfactory thermal conditions is the first of the problems with which the space engineer must contend. Closely allied to this, and given only second place in the volume is the ageing of surface materials primarily under the influence of solar ultra-violet light. On these subjects much valuable material on techniques and surfaces is presented.

There are some contributions on ultra-high vacuum and its effect on surfaces, mechanical strength and friction and some on sputtering, photoemission and erosion, but these proceedings on the first symposium are principally a text on optical properties.

The volume is produced a good deal more lavishly than necessary. It contains adequate references and is exceptionally well illustrated. Here and there the tendency for the engineer not quite to keep up with advancing knowledge comes out (not to mention the use of the Fahrenheit scale as well as Celsius). Thus a figure showing vast quantities of atomic nitrogen above 200 miles altitude is quite wrong and is an indication of the need for engineers to get together with physicists on these problems and not just to trust the first report that comes to hand.

This, it has been remarked, is the first symposium. Among the topics to which a second should address itself is the energy and momentum exchange between a satellite surface and impinging atoms and the effects of active atoms and ions on surface properties, mechanical strength and friction. If the high standard of the contributions and publication is maintained in the future a series of volumes of exceptional technical value in this new field will result.

R. L. F. Boyd

Electrodes are the Key to Erosion Economics

Spark Machining. Machinery's Yellow Back Series No. 46. *Machinery Publishing Company.* (5*s*)

The rapid development of a process, such as the working of metals by spark-erosion, becomes important when a large number of machines based on the process, all having a wide range of application, are likely to be the outcome. The spark-erosion machines now being used extensively in industry are generally alike as regards their working principles and basic circuit designs. Nevertheless each machine does have its own characteristics, either electrical or mechanical, and these distinctions are worth examination. But the advantages of the modern spark machine in this era of efficient production techniques, whatever form it takes, has been demonstrated and accepted by the production engineer.

Machinery are to be congratulated on publishing this book, which is an attempt to bring into focus the basic principles of spark erosion. It also provides an accurate and detailed account of the spark-machines now being made by companies at home and abroad. With the introduction of this unconventional method of machining, an entirely new avenue of thought in the field of manufacturing techniques has now been opened up, and its importance cannot be ignored by production engineers and designers. One factor that must be readily appreciated when considering the application of spark-machining is that the method is in no way a complete answer to machining problems, but used correctly with more conventional methods, it can help to create higher standards of efficiency in production.

The material in this book has appeared elsewhere in the columns of *Machinery*, but by bringing together this information the reader has an accurate survey of spark-machining applications. The section on spark-machining equipment is the most comprehensive in the book, and deals mainly with the individual characteristics of the machines in use throughout industry today. All these machines possess the basic requirements of machine tool design; simplicity, ease of operation, and safety precautions. The electrode and workpiece are alignable to each other in all cases. Reference is made to the recent development in high-speed stock-removal techniques. Claims of up to 6 cu. in of material per hour and reduced electrode wear properties, call for a reconsideration of existing die sinking methods and opinions. Spark equipment has been designed with the drop forging industry in mind, and has provided a semi-automatic method of producing dies of irregular shapes, ensuring correctness of form, accurate positioning and repeatability.

Electrode manufacture upon which the whole future of spark-erosion depends, has been treated very briefly, and a detailed survey devoted to this subject would be of immense value to the production engineer. The self-feeding characteristics of the equipment enables the process to be operated completely unattended and labour costs reduced to a minimum. But if the economies involved in making the electrode are high, the whole process becomes prohibitive. Every spark-machining problem has to be considered on its own merits, and the unique methods involved in the manufacture of the electrode is usually left to the imagination and skill of the machine operator.

The book is divided into three chapters, the final chapter being devoted to special spark-machining operations. This subject could well have occupied a greater proportion of the book instead of a few pages. Special applications cover a wide field and can be divided into two classes. First, the specially tooled standard machine, and second, the machine designed for specialised work. Examples of standard machines specially tooled for production methods are commonplace in industry today and the universal properties of the machine can be effectively used for this type of work.

The design and manufacture of special machines capable of carrying out toolroom or production work has gained momentum during the past few years and machines are now in existence for carrying out specialised work. Two examples can be cited here, one being a multi-head machine for machining blade retaining slots in Nimonic 75 material, and the other a production machine for the drilling of deep and accurate holes.

The book concludes with an index which is not very extensive, but covers most of the salient points mentioned in the previous chapters. This book should provide an excellent reference for toolroom and production engineers, but with the rapid developments now taking place in this branch of industry, future editions will have to be expanded if the publication is to be a comprehensive record of spark-machining.

Eric Foster

Permanent Way Foundations

Railway Works Construction. By H. M. Pearson. *Odhams Press.* (35*s*)

In his preface the author defines the purpose of the book as follows: it is intended to fill a gap in technical literature on the subject of railway works and it is addressed primarily to works supervisors. Nevertheless, even the experienced and professionally qualified engineer will find parts at least of the book well worth reading, in particular those on structural defects, organisation and control of works and contracts.

Very sound advice is given in many sections, particularly for those to whom it is addressed, on such matters as the need to be systematic in structure inspections and the writing of letters and reports and their illustration with sketches. For those in more senior positions the advice on the delegation of responsibility in order to give the best training to juniors is very much to the point.

Equally good is a section dealing with action to be taken in emergency. Basically much of the contents of such sections is commonsense, but experience indicates that it justifies repetition.

It appears from the text that the author has written the book around notes prepared for lecturing at the British Transport Commission Staff College. In consequence, the style is frequently rather verbose and not as is customary in a book text. As a result, many sections of the book, such as that on coastal defences, are more brief than they need have been.

In viewing the book it should, presumably, be considered as primarily for British Railways staff, in which case the space devoted to Statutory requirements and BR domestic practices in

works control by cabinet systems may be justified. Evidently in lecturing to BR supervisory staff it was necessary to dwell on such practices, the preparation of estimates, and elementary arithmetic. Similarly, in relation to the title and size of the book and, particularly if it is intended for wider circulation, proportionately too much space has been devoted to such matters as the Mines Working and Facilities Act, bridge classifications, the history of brickmaking and the growth of timber. By contrast, many of the illustrations are among the best examples of their kind, those concerning bridge erection and timber defects being especially so (there are minor editing errors in figure identifications).

It is, of course, very debatable whether, in endeavouring to achieve the impossible, namely the condensation of over a century of design and construction practice into one relatively small book, any space whatever should be devoted to such items as elementary arithmetic and matters such as Statutory regulations, all of which can be looked up readily in standard textbooks or Government publications. In the reviewer's opinion, what may have been required for a series of "domestic" lectures was not necessarily to be incorporated in a book for general distribution.

Owing to the very limited space available it is inevitable that many sections have had to be kept very brief and to this extent the book cannot be considered as entirely satisfactory. Nevertheless, one criticism must be made on the precision of statements in the book. Since it is intended primarily for those who have not had the benefit of advanced academic training it seems to the reviewer to be all the more important that everything stated should be accurate or, if not capable of exact statement, should be appropriately qualified.

Typical examples of loose or incorrect statements are the indiscriminate use of the terms "heat" and "temperature"; a statement that the thermal expansion of a 30 ft steel span is only about 1/100 of an inch; a case where it is overlooked that armour plate is generally high manganese steel; an impression that an alloy contains large proportions of non-metallic constituents; an incorrect statement about zinc; a failure to recognise that far more creosote is used for timber above ground than below ground; an allegation that all materials under stress suffer no volume change (approximately true only for rubber and some fluids); an illustration in which the arch thrust line is shown in the reverse position to that which it should occupy in relation to the load system shown; and a suggestion that dry rot is associated with a dry atmosphere (fortunately this is corrected overleaf).

It is a pity that such errors should have crept into a book which, in spite of its enforced limitations, will, as mentioned at the outset, undoubtedly prove of interest and value to those for whom it was written primarily. No doubt when a second edition is published the author will remove all cause for such criticism.

A. H. TOMS

The Reviewers

Mr. John Brodrick holds the B.Sc.(Econ.) degree of London University, and for most of his working life has been an economic adviser in the electrical engineering industry. He also spent a few years in the City. His work brings him into close contact with many top flight managers of British industry, and makes him familiar with the intricacies of business life.

Dr. Robert L. F. Boyd, A.M.I.E.E., F.R.Ae.S., whose academic training has included electric power engineering and ionic physics, is reader in physics and leader of the space research group in University College, London.

Mr. Eric Foster, A.M.I.E.E., Assoc.I.Prod.E., is spark-machining specialist with Burton, Griffiths and Company Limited, a member of the BSA Tools Group.

Mr. A. H. Toms is research assistant to the chief civil engineer of British Railways, Southern Region. He has previously served with Rendel, Palmer and Tritton on large-scale bridge and structural work, but since 1935 has been employed by British Railways, as assistant divisional engineer and in other capacities. He is a B.Sc., an M.I.C.E. and a fellow of the Permanent Way Institution.

New Books

Scandinavian Research Guide. Two volumes. *Scandinavian Council for Applied Research, Gaustadalleen 30, Blindern, Norway.* (70*NKr*)

A directory of over 1,500 Scandinavian research institutions in the field of science and technology, exclusive of life sciences. Details given of each institution include name, address, name of principal, number of staff, activities, policy regarding contract work, and serial publications.

Religion in Space Age. By JOHN LAMBLEY. *George Ronald, 5, Barandon Street, London, W11.* (10*s*)

The name of the publisher of the above was incorrectly given at the head of the review "A Faith Compatible" in last week's issue.

The Autocar Road Tests: Autumn 1960 Selection. *Iliffe.* (6*s* 6*d*)

This autumn's book of road tests reprinted from *The Autocar* contains reports on 19 recent vehicles, of which 11 are of foreign origin.

Industrial Development: A Guide for Accelerating Economic Growth. By MURRAY D. BRYCE. *McGraw-Hill, New York and London.* (58*s*)

Intended primarily as a practical manual for people working on the preparation, analysis or appraisal of industrial projects for underdeveloped regions. The author, with first-hand experience of this type of work in five continents, calls it "an elementary do-it-yourself guide on how to find and develop sound projects and get financing for them."

Heat Transfer. By ALAN J. CHAPMAN. *The Macmillan Company, New York and London.* (63*s*)

Rapid changes in modern technology make it necessary for the teaching of most engineering subjects to be more concerned with fundamental concepts and their application to physical problems, so as to fit the engineer to work effectively in a great variety of new and unexplored fields. The present author offers a fundamental approach at university level in a suitably rigorous manner.

The following German books, some of them second or third editions, are first class examples of the type of text book produced in Germany for the use of students at the Engineering Universities and Technical Colleges, and also for the practising designer who is not afraid of the theoretical aspects of his subject.

Einführung in die Korngrössenmesstechnik. By W. BATEL. *Springer-Verlag, Heidelberger Platz 3, Berlin-Wilmersdorf.* (27 *DM*)

An introduction into the techniques of measuring grain size in metals, together with a discussion of surface finish and sampling. Extensive bibliography.

Konstruction und Bauelemente von Strömungsmaschinen. By PETERMANN. *Springer-Verlag, Heidelberger Platz 3, Berlin-Wilmersdorf.* (12*DM*)

An excellent selection of cross-sectional drawings and photographs of typical fluid flow machinery by all the leading German firms, intended for use on design courses. No knowledge of German is needed to make use of it.

Kinematisch-getriebedynamisches Praktikum: Lehr- und Übungsbuch zur graphodynamischen Analyse ebener Getriebe für den Konstrukteur, die Vorlesung und das Selbststudium. By RUDOLF BEYER. *Springer-Verlag, Heidelberger Platz 3, Berlin-Wilmersdorf.* (29·40*DM*)

Examples in the kinematics and dynamics of mechanisms by one of the leading authorities on kinematics.

Repertorium und Übungsbuch der Technischen Mechanik. By ISTVÁN SZÁBO. *Springer-Verlag, Heidelberger Platz 3, Berlin-Wilmersdorf.* (24*DM*)

A useful collection of worked examples in the theory of structures, statics, and dynamics.

Fliesspressen von Stahl. By HEINZ D. FELDMANN. *Springer-Verlag, Heidelberger Platz 3, Berlin-Wilmersdorf.* (31·50*DM*)

The fundamentals of the cold pressing of steel, with chapters on materials, the uses of pressings, tools and presses.

Ingenieur-Mathematik. By ROBERT SAUER. Vol. I. *Springer-Verlag, Heidelberger Platz 3, Berlin-Wilmersdorf.* (24*DM*)

The first volume of a course in mathematics for honours degree engineers. Stiff but lucid.

Mehrspindel-Automaten. By HANS H. FINKELNBURG. 2nd edition. *Springer-Verlag, Heidelberger Platz 3, Berlin-Wilmersdorf.* (49·50 *DM*)

The second edition of a standard work on multi-spindle automatics.

Stufenlos verstellbare mechanische Getriebe. By FRIEDR. W. SIMONIS. 2nd edition. *Springer-Verlag, Heidelberger Platz 3, Berlin-Wilmersdorf.* (29·40 *DM*)

A good comparative anatomy of continuously variable-speed gears.

Flüssigkeitsgetriebe bei Werkzeugmaschinen. By HANDS KRUG. 2nd edition. *Springer-Verlag, Heidelberger Platz 3, Berlin-Wilmersdorf.* (39 *DM*)

A descriptive text on the forms of hydraulic drives found on machine tools.

Stauanlagen und Wasserkraftwerke. By HEINRICH PRESS. Volume 2, Wehre. 2nd edition. *Wilhelm Ernst and Sohn, Hohenzollerndamm 169, Berlin-Wilmersdorf.* (56 *DM*)

A sound introduction to the theory and practice of the design of weirs in Germany today.

Berechnung und Gestaltung von Metallfedern. By SIEGFRIED GROSS. 3rd Edition. Konstruktionsbücher, No. 3. *Springer-Verlag, Heidelberger Platz 3, Berlin-Wilmersdorf.* (21 *DM*)

The calculations and methods of design for all varieties of spring, illustrated by numerous tables and graphs.

Betriebs-Handbuch BH 59 für Pittler-Revolverdrehbanke. *Springer-Verlag, Heidelberger Platz 3, Berlin-Wilmersdorf.* (12 *DM*)

This admirable little handbook for Pittler automatics, besides performing its main function of giving instruction in the use of these machines, has the advantage that considerable sections of it are in German, English and French, and serve as a useful technical dictionary.

Einführung in die Spannungsoptik. By ALBRECHT KUSKE. *Wissenschaftliche Verlagsgesellschaft mbH, Stuttgart 1.* (38 *DM*)

A good introduction to the theory and practice of optical methods of stress analysis, intended for engineers.

Trade Publications

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Machine Tools

Woodworking Machinery. DOMINION MACHINERY CO. LTD., Hipperholme, Halifax. 36-page illustrated catalogue of woodworking machines including saws, planers, mortisers, lathes and moulders.

Filing Machine. VERROLEC LTD., 721 North Circular Road, London, NW2. Barson rotary filing machine, 10 in diameter ring or plate. Leaflet.

Bench Press. JOHN MARSHALL (ENGINEERS) LTD., 223 High Street, Henley-in-Arden, Solihull, Warwickshire. The JM 500 high speed bench press for strip material up to 5 in wide by ¼ in thick. Leaflet.

Surface Grinder. A. A. JONES AND SHIPMAN LTD., Narborough Road South, Leicester. Model 540 surface grinder, working surface 18 in by 6 in, described in 16 page brochure.

Guillotines. F. J. EDWARDS LTD., 359-361 Euston Road, London, NW1. The Besco-Truecut range of guillotines has models with capacities up to 120 in cut on ⅛ in mild steel. 8 page illustrated booklet.

Knuckle Joint Presses. HENRY PELS AND CO. LTD., 32 Osnaburgh Street, London, NW1. The Burger range of knuckle joint presses, hand or pneumatically operated. From 600 kg to 15,000 kg. Illustrated leaflet.

Pelleter. HENRY SIMON LTD., Cheadle Heath, Stockport. The Hyflo pelleting press, output up to 5 tons per hour of ¾ in pellets, is described in illustrated 6 page folder.

Swing Break Lathe. KERRY GROUP, Warton Road, London, E15. Illustrated brochure of 12 pages describes the Broadbent 40 in-84 in swing break lathe.

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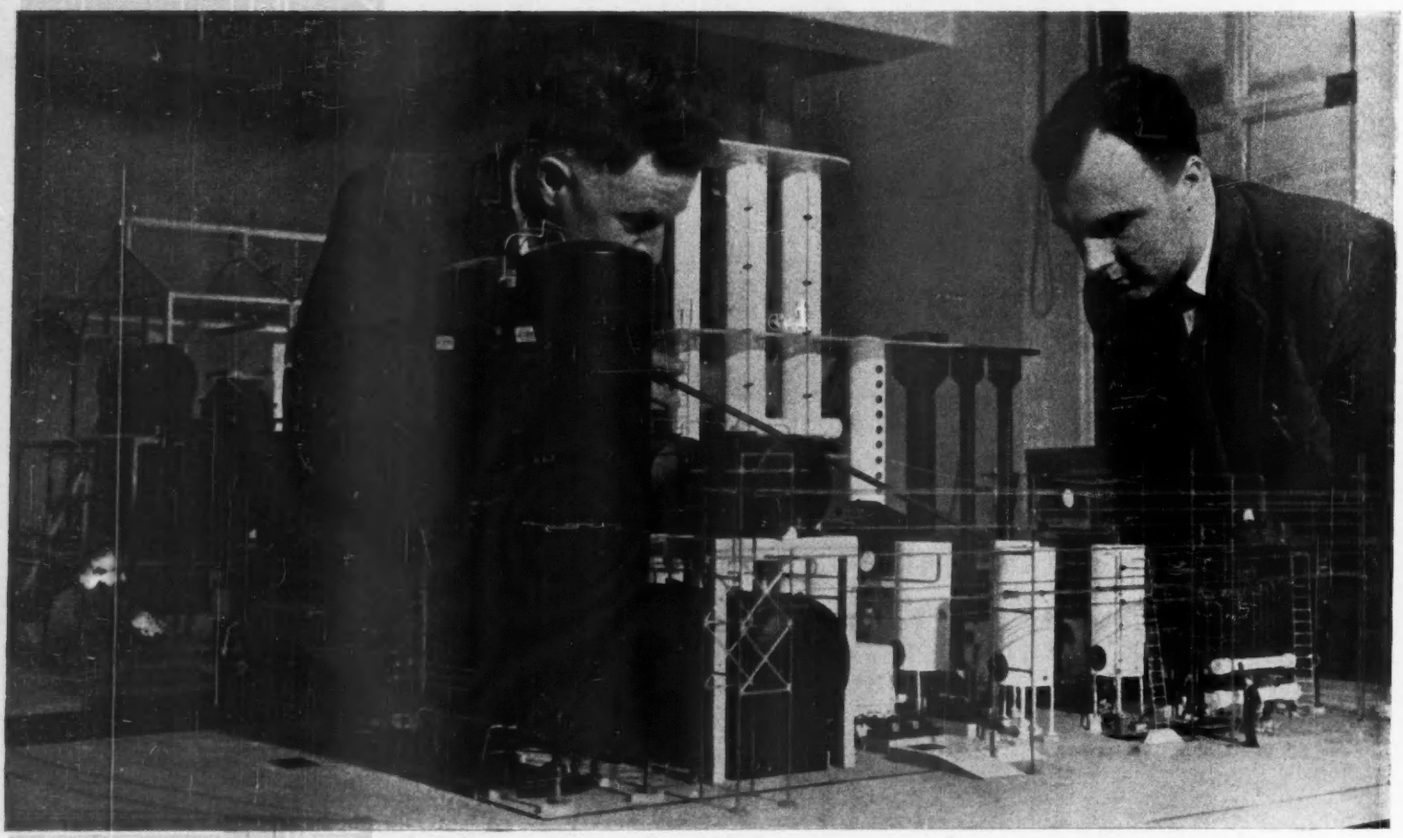

The Whessoe approach to complete chemical plant contracts is exemplified by the use of scale models to permit quick decisions on layout and spacing, to facilitate design and piping layout and to speed up site erection. The model illustrated is of a Tar Oils Plant designed to extract tar acids and bases from coal tar fractions. This continuous process plant is under construction at East Greenwich for the South Eastern Gas Board to the basic design of the Board's Chemical Engineer. Whessoe are responsible for engineering design, procurement, construction and commissioning.

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Marketing

A Saleswoman Named Suvretta

THE small shipbuilders of the United Kingdom are no less affected by the slump in orders than are their larger colleagues. An imaginative lead in selling their way out of the difficulties has been given by the Wallsend-on-Tyne shipbuilding company, CLELANDS, who have built the 111 ft long, 204 ton motor yacht Suvretta. She will combine the functions of a fee-earner from hiring out and of a travelling demonstration of what the shipyard can produce.

Powered by two eight-cylinder turbo-charged Rolls-Royce diesel engines, giving 350 bhp each, the Suvretta has a top speed of 13 knots. The yacht will be hired out at an average of £5,000 a month, rather more in the busiest season, and this charge excludes only fuel, food and drink.

Gyroscopically-controlled roll-damping fins, a specially designed bow, electric steering and radar aids to navigation are among the technical refinements of the Suvretta. She has received her first hiring reservation, and a sister ship, the Marco Polo, has been ordered from Clelands.

Increasing Competition from Italian Shipyards

While the report of the Department of Scientific and Industrial Research on research and development in the British shipyards goes once again over the well-trodden paths it is worth looking at the European Common Market, where Italy, whose shipyards are active in modernisation and redevelopment, has the largest merchant fleet of the European Common Market countries.

The main Italian ports increased their tonnages of goods shipped by twice the rate of increase in world trade in the first half of the year. The *Italian Trade News*, an official publication, estimates that, in the first half of 1960, goods passing through Italian ports amounted to 50 million tons, a 23 per cent rise over the first half of 1959. For 1960 as a whole, it is calculated that the total amount of goods moved by sea will be between 1,100 and 1,200 million tons, an improvement of between 12 and 20 per cent on the previous year.

Among the shipbuilders carrying through major improvement schemes, the ANSALDO SESTRI PONENTE yards are replacing six former docks with three capable of building vessels up to 85,000 tons. The turret cranes will have individual hoisting capacities of up to 60 tons and will be designed to operate in pairs when the need arises.

CANTIERI RIUNITI DELL'ADRIATICO have an agreement with BABCOCK AND WILCOX, New York, to build and sell nuclear-powered merchant ships.

In a comparison between the United Kingdom and Italian shipbuilding industries the point would certainly be made that Britain possesses many highly specialised yards with particular capacities. The trend in the Italian companies is constantly towards greater specialisation.

Developments in small cargo vessels, of various types for the Italian navy, and in port, utility, rescue and pleasure craft are all carrying the Italian builders further in the direction of competing throughout the world market. The addition to the Italian merchant marine of the liner Leonardo da Vinci underlined what the Italian yards can do in the luxury classes.

NCB Chairman Predicts Larger Coal Stocks

Mr. Alfred Robens, the National Coal Board's chairman designate, is gradually making his thinking plain as he moves about the country delivering speeches on the future of the coal industry.

Most recently he was in Manchester explaining why he is opposed to any reduction in the price at which coal from the Board's stocks should be sold. The stocks are expected to be down to less than 30 million tons before the New Year.

While he does not think that selling coal more cheaply would necessarily sell any more, Mr. Robens certainly believes that over the next two or three years the Board's coal stocks will prove to be very valuable.

The chairman designate, who takes up his post in February, believes that in future industry will probably be carrying much larger stocks of coal than in the past.

This assumption is a little puzzling when so much management attention is given to reducing the amount of money tied up in stocks, which are in effect no more than money standing idle. Winter weather apart, the pipe line for coal is a reliable one and there must be many coal burning firms who prefer to think of their supplies coming down the line, or even being conveniently stored by the Board, rather than taking up their own space, both on the ground and in the accounts.

Still, if Mr. Robens should be right in expecting more stock carrying by industry, then the conditions will be right for an annual sale of between 192 and 208 million tons.

Second Thoughts on Motor Warranty

It is the classic defence of the public company that the public is free to invest in it, providing the money for the company's further development and taking part as a shareholder in the affairs of the concern.

Rarely do the shareholders make the lively use of their opportunity that Mr. J. R. Lucas, an Oxford don and Fellow of Merton, made at the annual meeting of the BRITISH MOTOR CORPORATION. Mr. Lucas delivered some sharp views on the BMC practice of having their customers sign a warranty which excludes the warranties, conditions and liabilities implied by common law.

Mr. J. R. Woodcock, deputy managing director of BMC, has now said that the whole industry may be affected by the raising of the warranty issue and it may have to go to the Society of Motor Manufacturers and Traders.

Agreements between companies doing business together which state that they will have any differences settled by an arbitrator are common enough. No one suggests that there is anything there that should be looked into.

But the BMC warranty now has something of the appearance of an arrangement by which the customer surrenders his rights in exchange for what the company is prepared to allow him. Even now a BMC spokesman still says that it is the company's policy to interpret its warranties generously.

The point about resolving differences through the proper legal process is that the decision is put into impartial hands. It is this fact which should be pondered when second thoughts are entertained about the warranty in motor sales.

Widening Base of Northern Ireland's Industry

Any region of the United Kingdom that enjoyed announcing the establishment of 15 new branches of manufacturing industry and 14 significant extensions to existing firms in a period of 18 months could reasonably feel that it was an area of lively expansion.

Yet although in Northern Ireland this is exactly what took place between April, 1959, and October, 1960, the level of unemployment still remains stubbornly close to 6 per cent. Back in May, 1959, the proportion of the Ulster labour force without work was 7·9; in September of this year it had fallen to the still considerable level of 5·9 per cent.

The fourth annual report of the Northern Ireland Development Council says that some 5,000 jobs are expected to be made available by the developments announced or effected in the 18 months up to this October. The fall in unemployment is due so far to improvements in the engineering, building and textile industries.

It is of course a serious threat to the future that major unemployment is expected in the shipyards if the order position does not rapidly improve. Outside of a general revival in ordering tonnage from the British yards, Belfast hopes naturally turn in the direction of the replacement liner for Cunard.

The Development Council's report draws attention to the variety of industries now being expanded in their area. Definite plans exist for the manufacture of accounting machines, fertilisers, plastic products, dairy equipment, cutlery and tableware, boots and shoes, and aircraft ejector seats.

The powers in the hands of the Northern Ireland Ministry of Commerce for the assistance of new industry are substantial. The Industries Development Act enables the granting of sums towards capital expenditure. Using the Capital Grants to Industry Acts, the Ministry is also able to meet up to a third of a company's annual investment on plant, machinery and buildings.

Yet despite the favourable conditions that exist, Lord Chandos, the Development Council's chairman, finds that in meeting numbers of industrial leaders he is surprised at the gap between the facts about Ulster and the assumptions that are made, apparently without regard to the true position.

One of the most frequently brought up arguments when expansion in Northern Ireland is being discussed is the distance from London and the cost of transporting goods.

On the first count, as Lord Chandos points out, Northern Ireland, with growth opportunities unbeaten anywhere in the United Kingdom, is only two hours journey away.

On the second, the Development Council is investigating the importance of transport costs as a proportion of total production costs.

London Dock Strike Hides Dim Trade Picture

After the delayed effects of the London tally clerks' strike are taken out of the current trade figures, the disturbingly rapid increase of imports over exports is seen to have continued into November. Making the usual seasonal allowances, it appears that imports have been rising very nearly twice as fast as exports.

Exports in the three months September, October, November rose by 2 per cent above the level of the previous three months. Over the same period, imports rose by 3½ per cent.

The third quarter of the year showed a deficit in the current balance of £101 million, compared with a surplus of £43 million twelve months earlier. Declining earnings from oil revenues and shipping freights contributed to this position. These figures include the "invisible earnings," including oil, shipping and insurance.

In the restricted category of visible trade the deficit in the third quarter was £133 million, against a deficit of £41 million in the same period of 1959.

Analysis of import categories by the Board of Trade shows that semi-finished manufacturers topped the bill, increasing in value by 40 per cent, finished manufactures came next in the list of increases, going up by 25 per cent, and basic raw materials rose by 14 per cent.

CEGB Increasing Bulk Supply Tariff

Following their policy of gradually providing more of their capital needs from internal sources, the CENTRAL ELECTRICITY GENERATING BOARD are to make an overall increase of approximately 2½ per cent in bulk supply tariff charges to the Area Boards, for the year beginning 1 April, 1961.

In addition to the matter of capital costs the Central Board have also been affected by increased costs, which have included interest rates and higher wages and salaries.

The new charges level will mean a 3½ per cent increase on the normal fixed charge per kilowatt of maximum demand, an increase from 142*s* to 147*s*. There will also be a 2½ per cent increase on the basic running charge, lifting it from 0·41*d* to 0·42*d*.

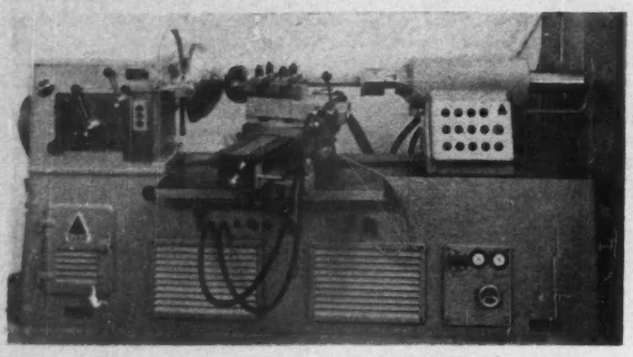
No departure is intended by the Central Electricity Generating Board from the long term trend towards a decreasing running charge. The increases are interim adjustments until a comprehensive review is made of the tariff structure. Five years ago the basic rate, now to be 0·42*d*, was 0·5*d* a unit.

British Built Bulk Storage for Moscow Bakery

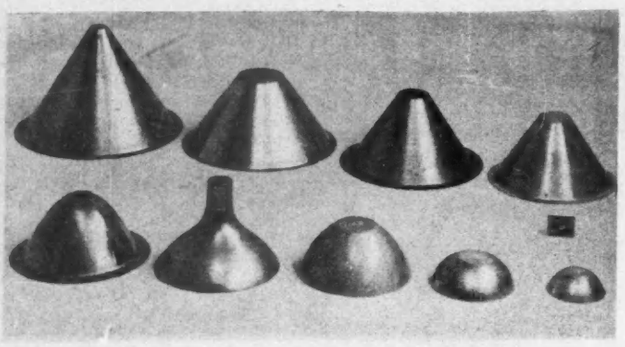
Moscow's No. 3 bakery is to have a plant for the handling and bulk storage of flour built by BAKER PERKINS. The contract for the plant is worth £127,000.

On similar lines to many such installations built for bakeries in Britain, the plant for Moscow will be able to store 420 tons of flour.

Pipework and the steel silos will be supplied by the Soviet authorities—to Baker Perkins drawings.



The ATM400S spinning and flow forming lathe. Operation can be automatic apart from loading and unloading.



A range of parts produced on the machine. Up to seven drawing operations have been replaced by one flow forming operation.

Flow Forming Lathe Cuts Tooling Costs

A new semi-automatic spinning and flow forming lathe has a multi-stage copying attachment which allows spinning "on air".

THE main application of hydraulic spinning and flow forming lathes has been in the production of aircraft components. In addition, however, they have a wide application in the batch and mass production of many other parts, such, for example, as drum tops, filling funnels, headlight reflectors, mixing bowls and similar products.

A new machine, introduced by the German concern, Leifeld and Company, of Ahlen, Westfalia, is specially designed for production of this type, employing unskilled labour. Designated the ATM400S, this semi-automatic machine can produce a complex range of shapes by means of a roller and spinning chuck on a hydraulically operated tracer device. A multi-stage template carrier allows spinning "on air," such that, at each pass, only a small reduction is effected. A general view of the machine is shown in an accompanying illustration.

The main drive is taken from a 5·5 kW motor by V-belts to the headstock which has a range of eight spindle speeds from 108 to 1,084 r.p.m. The alloy-steel main spindle is normally supplied with a threaded-spindle nose, but it can also be fitted with a quick-action cam-lock flange, in order to save time where quick tool changes are essential. It runs in taper roller bearings. Box frame construction has been employed to the close-grained cast-iron bed, in order to ensure maximum rigidity of the machine which is free from vibration when running.

A fully-hydraulically-operated compound rest is fitted to the machine. This can be positioned anywhere along the machine bed according to the type of operation to be performed and can be swivelled through an angle of 360°. Longitudinal travel is by means of a spindle and nut turned by an infinitely-variable drive from a hydraulic two-speed motor. The slower speed is used for the forward or working stroke and the higher for fast return. The pressure of the upper slide rest is variable between 0 and 1,000 lb per sq. in. and can be read directly off a pressure gauge. The top slide on which the spinning or flow-forming roller is mounted can also be swivelled through a small angle in order to adjust this roller to the best position for the work in hand. The variable pressure of the upper slide rest, which is exerted directly on to the spinning roller, enables direct copying to take place by following the contour of the spinning chuck.

The tailstock is hydraulically operated and carries at the front a control panel for the operation of all machine movements. A selector switch can be set either to "setting" or to "automatic cycle." In the former position, each movement of the machine can be adjusted separately, whereas, in the latter, the complete cycle of the machine will follow, one operation after the other, until the finished component has been ejected and the machine is ready to start operation once more.

Built into the bed of the machine is the complete hydraulic unit. It consists of a hydraulic oil tank in which is immersed a directly-driven three-stage high-pressure pump fitted with automatic stage control and maximum pressure valves. The maximum pressure can be adjusted by means of a hand wheel at the front of the machine and read directly off the manometer.

The machine is equipped with a completely self-contained switchgear cabinet housing all the electrical switchgear, the main switch and necessary fuses.

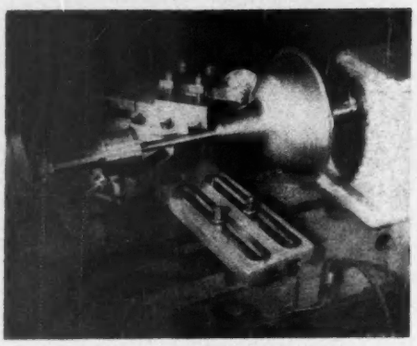
The centre height of the machine is 16 in and the distance between centres 46 in—the length of the bed being 106 in. The maximum blank diameter that can be accommodated is 24 in. The hydraulic compound rest has a longitudinal travel of 17 in and the travel of the cross slide is 8½ in. Feed rate in the longitudinal direction is infinitely variable from 0 to 140 in per minute in either direction. In the cross direction this figure is 0 to 80 in per min. The hydraulic tailstock has a stroke of 26 in and will exert a maximum pressure of 2½ tons.

In its standard form, the machine is not fitted with a template-controlled copying device. The spinning roller copies the shape of the chuck directly under the pressure of the hydraulic cross-slide cylinder. The blank from which the component is to be produced can be round, oval, square or any other shape. During processing by this method of flow forming, the outside contour of the blank is not changed. This particular process has its limitations, in that the minimum angle that can be obtained has been found, by experiment, to be 17° for parts up to approximately 7 in diameter, and 30° for parts up to 20 in diameter.

The angle between the tangent to the spinning chuck and the centre line of the machine determines the final thickness of the part to be produced. The product of the sine of this angle and the original thickness is equal to the finished thickness.

Production times depend directly on the length of travel in the longitudinal direction of the compound rest and the rate of feed, which, in turn, is determined by the material. The following rates of feed have been found to apply, based on a thickness of 0·08 in: mild steel, 8 in per min; aluminium, 4½ in per min; brass, 6 in per min; copper, 3¼ in per min; and stainless steel, 7½ in per min.

A very high grade of surface finish accompanies flow turning without the scratch marks such as are associated with drawing. In the majority of applications, it is not found necessary to treat further the surface that is thus obtained.



A close-up of the machine, showing an almost completed component.

The machine can, as already stated, be equipped with a hydraulically-operated tracer system, whereby the roller can follow the contour of a template. A multi-stage copy attachment can also be provided, whereby several passes with varying contours can be traced out. This particular method is particularly useful for work such as the necking of parts like milk churns and electric kettles. Hitherto, this type of work has had to be carried out on sectional chucks, the segments of which had to be placed one by one inside the part to be necked, and subsequently withdrawn. This multi-stage copying device enables spinning "on air" to be carried out in such a manner that, at each pass, only a small reduction is effected.

All movements of the hydraulic compound rest and the multi-stage tracer system are operated automatically in sequence. The operator merely feeds the machine, presses the control button and removes the finished article at the end of the cycle.

There are many instances where the tooling costs for spinning compare very favourably with those for the alternative drawing process. For example, in the production of industrial lighting fittings, as shown in the illustrations accompanying this article, one spinning operation which requires one chuck and one roller has replaced seven drawing operations. On a 14 in reflector, it is claimed that the tooling costs for drawing could be approximately the same as the price of a complete automatic spinning lathe.

The maximum blank thicknesses which can be accommodated by the ATM400S vary from 0·1 in for stainless steel to 0·275 in for aluminium. Leifeld's are represented in this country by the Embassy Machine Tool Company Limited of Hendon, London.

New Approach to Transformer Manufacture

A machine for cutting transformer core plates produces more accurate plates than previous methods. It has also overcome handling problems associated with this type of work.

RESEARCH work which has been undertaken over a period of several years into the properties and characteristics of cold-rolled grain-oriented steels has resulted in the evolution of new transformer core designs which, in turn, require extremely accurate manufacturing techniques. A unique and fully automatic core plate cutting machine has recently been installed in the transformer department of Ferranti Limited of Hollinwood, Lancashire. This produces core laminations from continuous rolls of steel to a degree of accuracy which, it is claimed, has never before been achieved.

Until the advent of grain-oriented cold-rolled continuous steel strip, core production was limited by the size of hot rolled electrical sheet steel which could be supplied by the steel manufacturer in a maximum plate size of 9 ft by 3 ft. With the introduction of cold-rolled steel in continuous coils, it soon became apparent that the capacity of available machines would set a limit on core production.

Because of this, Ferranti embarked upon a plant development programme with the object of introducing some measure of automation to core plate production to improve the limits to which core plates could be produced and, at the same time, overcome difficulties in handling.

To handle the continuous coils of steel supplied by the manufacturers, special purpose rotary guillotines or slitting machines were developed by Ferranti who installed such a machine in 1955. The purpose of this slitting machine is to reduce the width of the coil of steel to that required for the production of core laminations or plates. The machine consists of a decoiler which allows the coil to unwind and pass through the cutting head, where it is slit into strips of the required width. From the rotary cutters, the material passes to the re-coiler where the individual strips are rewound. This machine can handle coils up to 3 tons in weight and from 3½ in to 36 in wide. A maximum of eight strips can be cut at one set up and strips down to 1½ in wide can be produced.

The continuous strip, of the correct width, as received from the slitting machine was, until the installation of the new core plate cutting machine, reduced to the lengths required on conventional guillotine machines with subsequent press operations for punching slots and holes and edge grinding to remove burrs caused by the slitting and punching operations. Depending on the design of the core, the plates were either rectangular or a regular 45° trapezoidal shape.

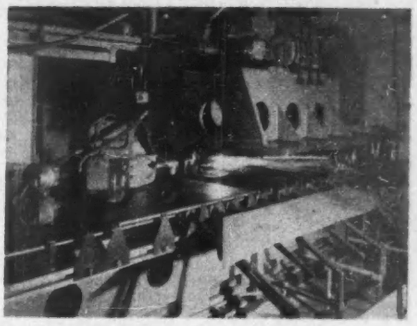
By this method of production, the limits to which individual plates were produced depended on individual guillotine and press operations working from the same datum point or stop each time. With the general increase in transformer size, plates of up to 15 ft long were being required regularly and the handling problems associated with this type of production began to approach the limits of human capability.

The new automatic core plate cutting machine combines in one operation the piercing of all holes and slots and the cutting of two plates per cycle of the machine. Provision is also made for grinding edge burrs if necessary. All dimensions are related to the theoretical centre line of the strip of material—that is, the centre line of the core. This has the advantage of dividing possible inaccuracies in the width dimensions equally to both sides of the plate and not to one side only, as in the case of guillotine or press production where all measurements were made from one datum edge of the material. The possibility of variations in length dimensions occurring due to human error in the case of guillotine and press production have been eliminated by cutting both ends of each plate and punching all holes and slots in one operation of the machine while the strip of material is in tension.

The accompanying diagram shows the layout of this plant with its control equipment, the bed of the press being 30 ft long and 4 ft 8 in wide.

The sequence of operations, after the tools for end, hole and slot forming have been set, is first to load the de-coiler (A) with a coil of material of the width and grade required. With the machine under manual control, the material is fed round the swinging arm (B), and through the feed rolls (D) until the leading edge is beyond the first end forming tool (E_1). The machine is operated by foot control and one set of holes or a slot is pierced by piercing tools (F_1) and a 45° mitred end formed by tool (E_1). The piece of scrap material lying beyond (E_1) is removed and the press switched to automatic control.

The automatic sequence then follows. The feed rolls (D) draw the material from the loop between (D) and (A) passing it under the piercing and end forming tools. When the swinging arm (B) is pulled sufficiently far from the at-rest position, contact across the photoelectric cell (C_1-C_1) is made and decoiler (A) is operated, thus supplying more material to the feed rolls. As the leading edge of the material interrupts



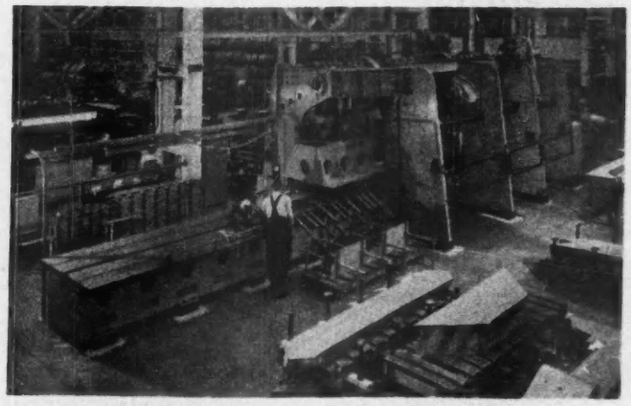
A close-up of the machine, showing automatic ejection of a finished plate.

the second photocell (G_1-G_1) the rate of feed is cut from 200 ft per min to 0·5 ft per min until the leading edge hits a microswitch in the hydropneumatic press unit (H), when the unit operates and punches a small anchor hole in the material, the punch remaining in the material. The action of punching the hole immediately opens one pair of the main feed rolls (D) and causes the other pair to reverse, thereby pulling out any ripples there may have been in the material.

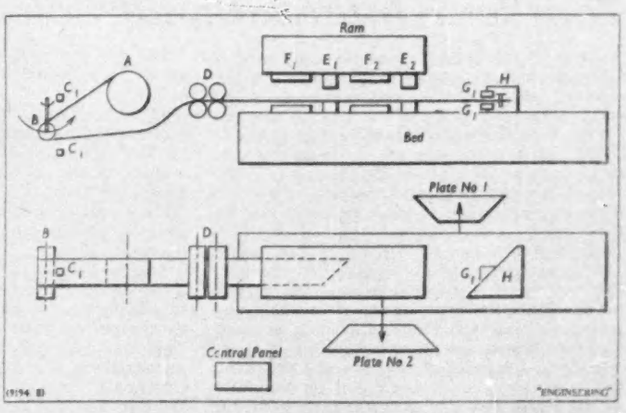
Slow tensioning of the material continues until the electric clutch through which the rolls are driven starts to slip, when a hold-down ram in the feed roll unit (D) operates and holds the material in the tensioned condition. The reversing rolls return to the disengaged position and the ram operates, cutting and piercing two complete plates. As the ram rises, all side stops are lowered and the piercing tool in the hydropneumatic press unit (H) is withdrawn, thus setting in operation the ejection mechanism which ejects one complete plate to the back and the other to the front of the machine where they are automatically stacked on pallets.

The machine, which is operated by two men, can produce between 360 and 480 plates an hour. It is fitted with adequate safety devices at all stages of operation. It has been in production since July, 1960, and has achieved the original objectives of producing core laminations to a higher degree of accuracy than previously possible—resulting in an increase in core efficiency. It has also overcome handling difficulties with consequent increase in productivity.

The machine was manufactured to Ferranti design by A. Kinghorn and Company Limited of Todmorden, Humphries and Sons Limited of Poole, and the Norbury Engineering Company Limited of Hyde.



The machine viewed from the extension bed end, showing material in tension prior to press operation and ejection.



This diagram shows a side elevation and plan of the fully automatic core plate cutting machine.

New Theory for Parallel Surface Thrust Bearing

By A. Cameron, Ph.D.

Mechanical Engineering Department, Imperial College, London

The parallel surface thrust bearing consists of two flat and parallel plates, the rotating surface is plane, while the fixed plate has several deep lubricant grooves cut in it. This type of thrust bearing was first described by Beauchamp Tower[1] in 1891. At that time no one commented that it apparently contravened Reynolds' theory, which required a convergent wedge for the formation of a load-carrying oil film. Harrison[2] considerably later (1919) realised this contradiction and suggested that there might have been a chamfer on the edges of the grooves and this formed the pressure, but he gave no quantitative data to support his idea, which in fact cannot account for the load carried.

The matter was forgotten till Fogg[3] rediscovered the bearing and suggested that its action was due to the thermal expansion of the oil. This has been considered by a number of workers, Cameron and Wood[4], Shaw[5], Osterle Charnes and Saibel,[6] and the conclusion is that it is not "powerful" enough to explain the very good load carrying capacity of the bearing.

Zienkiewicz[7], Hunter and Zienkiewicz[8] and Cameron[9] then sought to show that the variation of viscosity *across* the oil film could explain the action of the bearing. Due to the complexity of the mathematics the result is very markedly influenced by the values taken for the temperatures of the bounding surfaces. Cameron following the analogy of a moving heat source across a semi infinite solid, postulated the *fixed* bearing pad was of constant temperature while the temperature of the moving surface rose steadily from inlet to outlet.

Christopherson[10] in the Institution of Mechanical Engineers' 1957 Discussion on Lubrication, showed, however, that the surface temperature of the *moving* surface would remain substantially constant. A number of measurements of the temperature of pads showed that this varied in temperature, rising almost linearly from inlet to outlet.[11] This reversal of the model chosen by Cameron would lead to a *lowering* of the load carrying capacity, rather than an increase, resulting from the variation of viscosity.

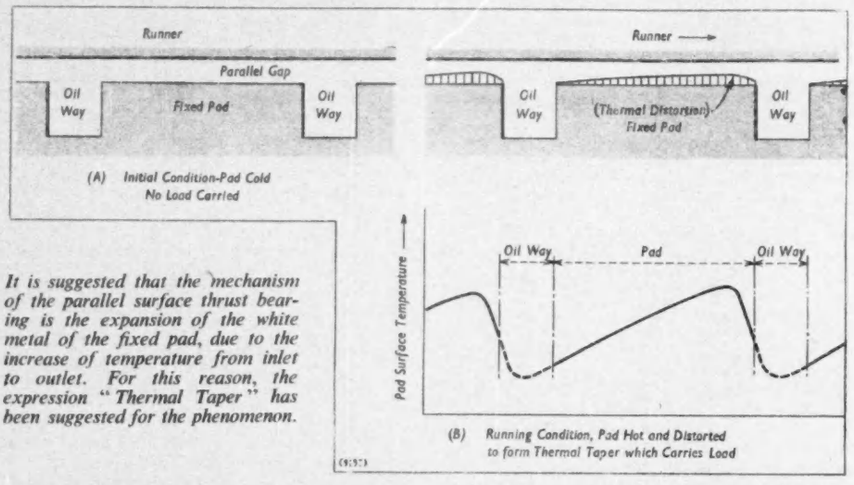
This pattern of temperature does, however, suggest a most plausible mechanism for the parallel surface thrust bearing, which usually consists of a steel runner and a white-metalled fixed pad. The pad is bounded by oil grooves supplied with cold oil, the pad surface increases in temperature approximately linearly, from inlet to outlet. This will mean the white metal surface will distort by thermal expansion. The distortion will be greater the higher the temperature, and so an originally parallel oil passage will become converging.

An approximate analysis of this can be carried out as follows.

Consider a pad 1 in long in the direction of motion with white metal $\frac{1}{8}$ in thick. Assume the pad is running with a minimum oil film thickness of 1×10^{-4} in. For optimum performance the inlet oil film thickness must be 2·2 times this. Thus a surface expansion of 1·2 times the minimum film thickness, i.e. $1{\cdot}2 \times 10^{-4}$ in, gives the optimum Michell wedge. The coefficient of thermal expansion of white metal is 20×10^{-6} per ° C, so assuming the temperature is uniform over the *thickness* of the $\frac{1}{8}$ in white metal, a temperature rise of only 48° C is needed to produce this expansion, and this is easily achieved.

It would appear likely, then, that the mechanism of the parallel surface thrust bearing is the expansion of the white metal of the fixed pad, due to the increase of temperature from inlet to outlet. For this reason the name "Thermal Taper" is suggested for the phenomenon.

This mechanism is illustrated in Fig. 1. In 1A, the initial conditions are shown. The pad is cold and the surfaces flat, giving parallel gap. In 1B, the running state is shown. The surface of the pad has heated up and consequently distorted. This causes the converging wedge which enables a load to be carried.



It is suggested that the mechanism of the parallel surface thrust bearing is the expansion of the white metal of the fixed pad, due to the increase of temperature from inlet to outlet. For this reason, the expression "Thermal Taper" has been suggested for the phenomenon.

Detailed theoretical and experimental work is being carried out along these lines in the Lubrication Laboratory at the Imperial College of Science and Technology, London.

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Ten-Year International Science Programme

A series of recommendations that may govern Unesco's natural science programme for the next ten years has just been approved by the programme commission of the Unesco General Conference's Eleventh Session, held in Paris.

The recommendations are made in response to a survey on the main trends of enquiry in the field of the natural sciences, recently completed in implementation of a resolution adopted by the United Nations General Assembly in 1958, under the direction of Professor Pierre Auger of the Sorbonne, former director of Unesco's Department of Natural Sciences. The survey, which covers the main trends of scientific and engineering research, the dissemination of scientific knowledge and the application of such knowledge for peaceful ends, is to be submitted for comments to other specialised agencies such as the Food and Agriculture Organisation, the World Health Organisation, the Atomic Energy Agency and the Governments of the member states of these organisations.

The Unesco recommendations give priority for the next decade to activies in three main fields:

(1) Coordination of scientific activities on both national and international levels.

(2) The exploration of the earth's resources and a study of the scientific problems involved in harnessing them.

(3) The applications of science and technology for the industrialisation of less developed countries.

The machinery of coordination of scientific activities must be strengthened to avoid unnecessary duplication of effort throughout the world, the recommendations point out. It is proposed, therefore, to stress collaboration among scientific organisations, the standardisation of scientific abstracting services and of units of scientific measurement, and improved translation of technical articles.

Concerning the exploration of the earth's resources, a number of concrete suggestions are made. They entail more extensive study of means of investigating natural resources—whether by geophysics, geochemistry, or aerial surveying—and problems of the exploitation and conservation of natural resources.

Particular attention will be given to geological and seismological research, following recent earthquakes which have ravaged large areas in Latin America and the Mediterranean basin. During the next two years, Unesco will send out survey missions to the world's seismic zones.

Beginning in 1963, it is proposed that Unesco should form a committee of experts to report on all problems involving pollution, whether of air, water or soil, which are too extensive to be dealt with on a national scale.

Finally, in the third priority field concerning the industrialisation of developing countries, it is planned that Unesco should concentrate on the training of scientific and technical personnel and a study of the methods of speeding industrialisation in under-developed regions.

Tyre Tests to Reduce Noise

In their efforts to increase passenger comfort, and as part of a general campaign against noise, manufacturers of automobile tyres are carrying out a number of development programmes. These are being directed toward analysing the various types of noise and their effects and to establishing the means of remedy.

To carry out this work, a substantial amount of test equipment has been specially designed or adapted to detect the factors which might make a tyre vibrate, rumble or whine, under normal road conditions.

In the laboratory of the Goodyear Tyre Company, a test tyre is run against a steel drum coated with abrasive material. A microphone and recorder are then used to pick up the noises created. Then, using the recording, instruments are used to determine the total volume, frequency spectrum and the pattern of frequencies.

When the laboratory test is completed, the tyre is mounted on a car and run on a road surface while engineers listen in from both inside and outside the car. The main value of this subjective measurement lies in the fact that the human ear and mind can "screen" out all other noises and rate the tyre on its own qualities.

A combination of subjective tests and instrument analysis is essential in this type of work in order to obtain usable quantitative data.

DSIR Recommendations on Marine Engineering

The recent DSIR report "Research and Development Requirements in the Shipbuilding and Marine Engineering Industries" points out that the world shipbuilding industry is facing a major, and probably prolonged, recession. The report also states that the total effort at present devoted to research and development in the field of shipbuilding and marine engineering is insufficient for present-day needs.

In their analysis of the situation, the DSIR have singled out a number of engineering techniques that are, in their opinion, worthy of further development effort. Heavy welding techniques and the continuous welding of vertical seams, are two examples. Another example is the flame cutting of ship's plates, a technique now used in a number of yards both in the United Kingdom and on the continent. In connection with the further use of computers, British Oxygen Gases Limited and Ferranti Limited are developing a computer-controlled flame cutting machine which will automatically control the cutting of steel plates from information recorded on tape. The first two of these machines, according to the report, will be installed in British shipyards very soon.

For all practical purposes at the present time, the choice of propulsion machinery for ships lies between steam turbines and diesel engines. In the latter category, there is little doubt that continental designers are leading the field. In Britain, as the report points out, there is no diesel engine designer with large enough production to support research or development on a sufficient scale to put Britain ahead. What resources are available have so far been concentrated on the medium size-range engines. For this reason it is thought that diesel engine development should be a subject for government or civil development contracts.

The free-piston gasifyer, with its low fuel consumption, simple maintenance and vibration-free characteristics is another course which the DSIR report recommends for further investigation.

Other lines of development of the gas-turbine may also be important in the long run. Since the experimental gas-turbine installation in the Shell tanker Auris, little work has been done in this field. Work has been carried out by PAMETRADA for the Admiralty on liquid cooled blading, but Admiralty support has now been withdrawn as a result of cuts in defence expenditure and of a realisation that, even if the project were proved technically feasible, the gains in relation to complexity (*vis-à-vis* an air-cooled turbine) would not be sufficiently rewarding for naval purposes.

There is, however, a strong case for pursuing investigations for merchant purposes. Investigations should include the possibilities of burning heavy fuel in gas-turbines and the metallurgical problems associated with running at very high temperatures. In the long run, this may also assist in the development of the high temperature gas-cooled reactor for marine propulsion.

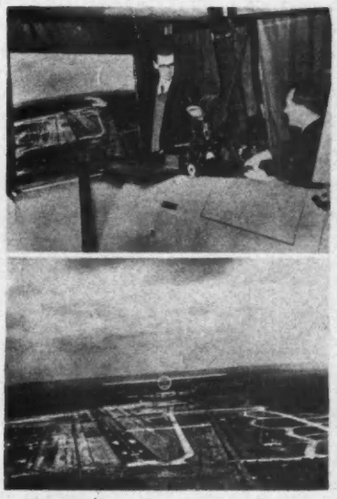
Another point mentioned in connection with marine propulsion is that, though there is clearly a case for the continued development of the slow-running single diesel engine, further work might also usefully be done on the development of multi-coupled medium speed diesel installations.

In the conclusions of the DSIR report, emphasis is made of the importance of research into production techniques and methods aimed at increasing productivity and reducing costs. It is thought that the DSIR and the Ministry of Transport should consider, together with the shipbuilding and marine engineering industry, what assistance would most appropriately be given to promote research in this field.

Aircraft Instrument Display will aid Pilots

A new technique of aircraft instrument presentation, expected to be of immense value to both military and civil aircraft pilots, has been developed at the Royal Aircraft Establishment, Farnborough, Hants.

Known as the "head up" system, it makes use of the reflector gunsight principle to present such vital data as attitude, altitude and angle of elevation on the pilot's windscreen. This means that the pilot does not need to look down at his instrument panel so often, so that there is less chance of a collision. Furthermore, the pilot can steer a more accurate course, particularly at very high speeds.



A new flight simulator and steering display. The top illustration shows how the pilot can fly with his head up, looking straight out of his windscreen and seeing his guidance symbols superimposed upon the landscape (bottom illustration).

The display shows the pilot when to alter direction or height and notifies him of the rate at which he does so, as well as indicating to him the effect of his stick movements—all without the need for him to look away from his windscreen. Moreover, the symbols are matched in focus (at infinity) so that the pilot does not need to refocus his vision.

The Royal Air Force's visual flight simulator has been extensively used in developing the technique and has enabled many hours of simulated flying time to be carried out in the laboratory. Actual flight tests have also been made in a meteor jet fighter.

RAF pilots who have tested the system, both in the air and on the ground, have described it as a breakthrough in aircraft control instrumentation. Quantitative laboratory tests have indicated that the accuracy with which flight directions can be followed is twice as great as with present-day techniques. Outside objects can be seen about three seconds sooner with the head up system.

Laboratory tests have also shown that a pilot can learn to use the system in an incredibly short space of time. In the course of a recent demonstration, using the flight simulator at the Farnborough laboratory, two members of the technical press (both ex-pilots) were given two or three minutes to acquaint themselves with the new system, whereupon they were able to "fly" it with skill comparable to that of one of RAE's top experimental test pilots.

Development work on this new technique, which has so far engaged about ten men for the past four years, is still continuing and it is expected that further developments may arise.

Metal Stitching Repair Technique

A novel "stitching" method of repairing a cracked metal case *in situ* was recently used at the Royal Aircraft Establishment, Farnborough, Hants. The crack in question was one that appeared in the water jacket of RAE's 7,000 hp axial flow compressor at Ball Hill.

Because the crack was allowing cooling water to leak into the tunnel circuit and urgent research work was in progress at the time, it was vital to carry out a speedy repair. The top half of the downstream compressor casing was removed to expose the cracked water jacket, and various methods of repair were discussed.

The water jacket, which was approximately ¾ in thick with internal webs, had a rapid change of section adjacent to the crack, so it was decided to carry out a cold repair to avoid any heat distortion. There was also the added advantage that work could thus be carried out without any need for further dismantling.

The process decided upon entailed drilling a series of accurately spaced holes along and across the line of the crack. These holes were drilled to a predetermined depth so that they did not penetrate the casing.

The metal between the holes across the crack was chipped out and high tensile steel keys inserted followed by a strip of soft steel which was then hammered over to give a pressure-tight seal. The tops of the holes were undercut so that, when the soft steel strips were hammered in, they securely anchored the hardened steel keys in position. These hardened keys were intended to take any stresses induced in the casing when in use.

The holes along the line of the crack were threaded and soft steel plugs screwed in and peened over.

The repair was tested at 50 lb per sq. in, but it is believed that repairs of this nature could withstand considerably higher pressures. The time for the repair job was only eight hours, including pressure testing.

Although this was the first time that this process had been used by the Royal Aircraft Establishment, it is now to be considered by them whenever work of a similar nature arises. There are obvious advantages in being able to carry out work on site without the expense and time involved in dismantling, and there is the added advantage that distortion does not occur due to heat.

Construction of Water Turbines in Russia

Until the thirties no water turbines were built in Russia but their engineering industry is now capable of supplying all machines needed for their large and numerous hydro-electric schemes.

By O. Tedder

SINCE the bulk of Russian reserves of hydro-electric power are contained in the large lowland rivers, mixed-flow and feathering-propeller turbines are the main types built in the Soviet Union, although the industry has also supplied some impulse turbines.

One of the first Russian designs was the vertical-shaft turbine built for the Mingechaursk hydro-electric station; this machine is typical of the Russian medium size mixed-flow turbines and it has since been delivered to many other plants. The turbine has an output of 62 MW, a head of 62 m and a diameter of 4·1 m. It has a welded metal spiral casing with a butterfly valve at the entry. The elbow draft tube is a concrete structure. Two servomotors are used to operate the guide vanes.

For high-head work the turbine casing is made of cast steel and the runner of stainless steel; the valve used in such cases is of spherical type and mounted in front of the casing. The machine has an emergency by-pass.

The feathering-propeller turbine is the type most suitable for Russian hydro-electric power schemes with their low heads and large discharges, for which reason it has become very popular in that country. It has been built with runner diameters of up to 9·3 m, heads up to 35 m, and for capacities of up to 126 MW, while units of up to 300 MW capacity are in the design and test stage.

A typical earlier design of this type is the turbine for the Kama scheme which has a power output of 21·8 MW and a runner diameter of 5 m and a head of 21 m. It has a concrete spiral casing and elbow draft tube. The thrust bearing is placed on the turbine top-cover which renders the height of the set very low. The turbine and the generator have a common shaft, which is guided in two bearings. The generator stator is carried by a metal support which forms the turbine chamber. This enables the unit to be compactly made and it can be placed directly into the dam of the station.

The first really big project with which the Russian water-turbine industry was faced was the construction of 20 sets for the Volga power station at Kuibyshev.

With an output of 126 MW at a head of 22·5 m and a runner diameter of 9·3 m, these turbines are claimed to be the largest of their kind in the world, their nearest rivals being the turbines of the Vargon plant (runner diameter 8 m) in Sweden and the Dalles Dam machines in the USA with an output of 91·3 MW.

The successful design of the runner and water passages enabled a maximum efficiency of 94 per cent (in model tests) to be achieved, the compact design enabled the shaft to be supported on the turbine cover. Welding was adopted for the construction of many components which are usually cast in these turbines.

Much preliminary work was done in the form of extensive research on many existing power plants. This work was mainly concerned with finding the necessary design data by investigating the distribution of pressures, deformations and vibrations. It produced a clear picture of the stressed condition of individual components to be designed in a closer conformity with the actual requirements, thus achieving considerable savings in weight and costs.

DRAFT TUBE

In recent years there was a tendency among the Russian designers to work with an increased specific discharge in order to obtain a smaller runner diameter and hence a reduction in the dimensions of the entire plant. In particular, the increased discharge enabled the draft tube to be kept low which considerably cuts the cost of the underwater construction work, which is the most expensive part of the plant. However, laboratory experiments and the observation of turbines in operation have shown that here a more cautious approach is advisable and that in high-speed turbines with large specific discharges no suction tubes with a diameter of less than 1·9 D should be used, (D being the runner diameter.) A too low draft tube not only reduces efficiency but also causes rough and noisy operation of the set, and increases the velocity of the flow and consequently the draft tube losses.

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Fig. 1 The characteristic feature of the turbine for the Krasnoyarsk scheme is the relatively small size of the water passages, which requires an intense utilisation of the energy of the flow by the runners.

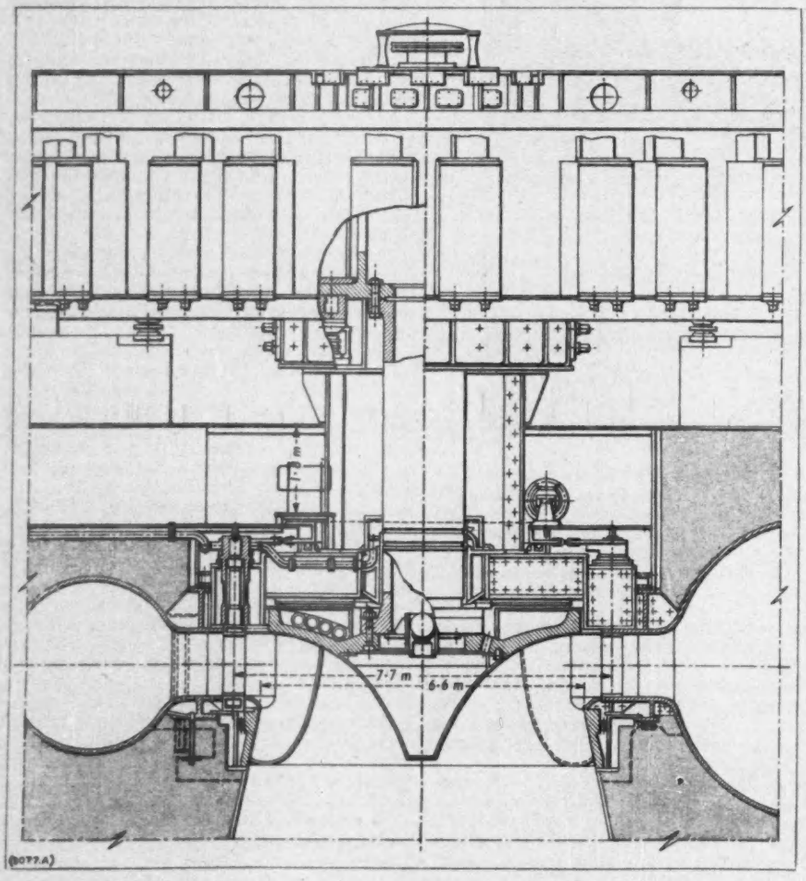
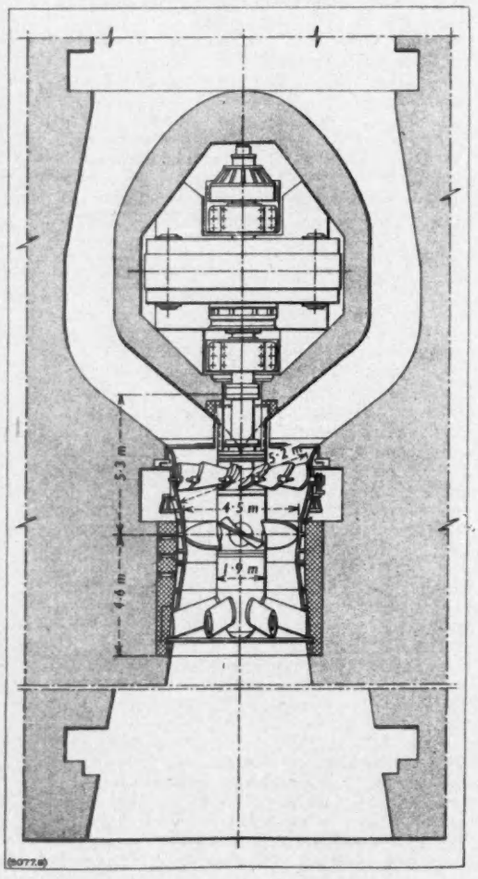


Fig. 2 A semi-direct flow turbine which is now in operation in the Kama hydro-electric power station. The turbine has an axial guide apparatus and a straight suction tube.



The runner blade operating gear of all Russian turbines is of identical design. The blades are adjusted by means of a crank mechanism which is operated by a servomotor mounted inside the runner hub. This design is considered the most satisfactory because it ensures a short and reliable connection to be obtained between the blade cranks and the servomoter. The supply of oil to the runner servomotor is always from a container located above the turbine in the machine hall, with the oil supplied through a hollow shaft. Although this method is still considered entirely satisfactory, the recent tendency to construct open hydro-electric stations calls for new solutions, such as the supply of oil through the shaft near the bearing, which is expected to involve some design difficulties.

The reliability of anti-racing devices is a point of great importance not only for the operation but also for the design of water turbines, since on it depend the maximum centrifugal forces for which many components are dimensioned. And it is of particular importance for feathering-propeller turbines which can achieve much higher runaway speeds than the mixed-flow type. After laboratory tests and tests on working turbines in addition to taking practical experience into account, the Russian designers arrived at the conclusion that gates operated by special quick-acting devices are the most dependable safeguard against damage caused by runaway speeds. The movable vanes in front of the guide apparatus —which in effect represent a second guide apparatus—are considered unsuitable for the purpose, mainly because they require a substantial increase in the overall structural dimentions of the station.

The use of hydraulic brakes or the turning of the runner blades into the open position, is considered to be unsuitable for large machines since they are based on the dissipation of energy and can lead to dangerous vibrations of the set. The closing of blades, on the other hand, is not sufficiently effective since during the closing period the runner can reach a substantial speed and its parts must therefore be designed to withstand the resulting forces.

A satisfactory protection against overspeed is offered by an emergency valve which supplies oil into the vane servomotors independently of the main valve of the regulating system. The reliability of this method can be increased still further by duplicating the linkage or by fitting the guide apparatus vanes with individual servomotors. The tests carried out in the Volga power station proved their reliability. These tests also showed that at a normal head the turbine developed its normal speed with only two vanes remaining open and could not be stopped without the use of the gate. At the maximum head this should occur with one vane remaining open.

NEW TURBINE DESIGNS

The utilisation of the power of large Siberian rivers has confronted the Russian water turbine designers and manufacturers with the problem of constructing very large high-head machines. The Bratsk hydro-electric scheme on the River Angara (total power 3,600 MW) will require turbines of 200 MW for a head of 96 m, while the Krasnoyarsk scheme on the river Ob (total power 4,250 MW) needs sets of 300 MW for the same head. In future turbines of 400-500 MW for 150 to 200 m heads will be required.

The characteristic feature of the turbine for the Krasnoyarsk scheme, shown in Fig. 1, is the relatively small size of the water passages, which requires an intense utilisation of the energy of the flow by the runner. The runner will be of welded design and consist of several parts. Its bottom and top rims will be cast separately and then welded into a single unit.

Tests on models show that in designing this turbine special attention will have to be paid to the low-pressure zone which is formed in the flow behind the runner by a spinning vortex train. It is expected that the elimination of this zone will require the admission of air into the flow.

Work is now in progress in Russia on the development of horizontal direct-flow turbines for spillway power stations. The horizontal layout enables a simpler design of water passages to be obtained, with resulting lower construction costs of the station. The efficiency of these turbines is also better than that of the vertical-shaft type.

One such turbine is now in operation in the Ortochal'sk hydroelectric power station. The generator rotor of this set is mounted on the rim of the turbine rotor. The operating mechanism of the movable blades is mounted inside the runner and incorporates a servomotor.

The operating experience of this turbine shows that many difficulties must be overcome in order to obtain a reliable joint between the runner and the turbine and the generator rotor. The assembly and dismantling of the set is also difficult and requires a good solution of the problem of the runner seal. The generator winding must be completely waterproof

A semi-direct-flow turbine is now in operation in the Kama hydroelectric power station (Fig 2). The output of this turbine is 21·8 MW, at a head of 21 m, and its runner diameter is 4·5 m. The turbine has an axial guide apparatus and a straight suction tube. The generator is mounted in a concrete chamber and the water is supplied by two channels.

Boeing 727 Confirms British Aircraft Concepts

Severe competition between Britain and the United States for aircraft suitable for short-haul traffic must now be expected as a result of Boeing's announcement of their 727 jet airliner. Eighty have so far been ordered.

The competition will come from the de Havilland Trident (DH 121), which although announced about two years ago, may not be ready much before the Boeing. The similarity between the two planes is very striking and it would seem that American designers have been influenced by the DH 121. It was known at the time the DH 121 was conceived that BEA—who have 24 on order with an option on 12 more—had strong preferences for rear mounted engines such as these two planes both have.

Dimensionally as well, the planes are very similar. Wing span for the Boeing is 108 ft while the length is 134 ft. The DH 121 is 90 ft and 114 ft respectively. The Boeing will carry from 70 to 114 passengers at up to 600 m.p.h. and the DH, 76 to 100 passengers at a similar speed.

The new Boeing 727 (right) and the de Havilland 121 Trident (left). Comparisons must be made with reservations, but they share a similar appearance, are much the same dimensionally as well as having a comparable specification for number of passengers and range.

Smallest member of America's first family of jet airliners, the 727 is the first Boeing to depart from the wing-mounted engine installation. Instead, it has a three engine arrangement with an engine pod on either side of the fuselage and a cowl-enclosed third engine suspended from a beam with an air duct leading to it from the base of the vertical fin. The engines are Pratt and Whitney JT 8D Turbofan each rated at 14,000 lb thrust. Thrust reverses are fitted on all three engines.

Like the pod-mounted engines in all the other Boeing jets, all three of the aft-mounted powerplants are isolated from the primary structure of the airliner. It seems that American designers have always been rather dubious of mounting the engines integrally with the wing or fuselage because they feel that fire risks are greater.

The arrangement adopted on the 727 is, say the Boeing engineers, the best way to place three engines on an aircraft such as this. All other possible methods were explored during more than four years that have elapsed since design studies were initiated. Apparently de Havilland engineers came to the same decision.

It is interesting to note that although the 727 is appreciably smaller than the Boeing 707, the fuselage width is the same, thus providing the same cross-sectional space and the same degree of luxury on short-haul service as is found on transcontinental flights. The fuselage depth of 12 ft 8 in leaves space for two cargo compartments, one forward and the other aft of the wing, with a total capacity of 800 cu. ft.

Low speed performance is built into the wing by means of high-lift devices. These consist of triple-slotted trailing-edge flaps and leading-edge flaps and slats. The slats—which were installed on the XB 47 Stratojet—extend forward and down from the upper leading-edge of the wing at low speeds, forming a slot. For cruising flights, the slats retract on to the wing giving a leading edge which provides excellent high-speed characteristics.

The 727 control system differs from that of the earlier Boeing jetliners by incorporating changes found worthwhile with the experience gained. The 707 series depend on aerodynamic boost to power ailerons and elevators, and a combined aerodynamic and hydraulic boost for the rudder. The 727 uses the same aerodynamic actuation in the elevator and aileron controls, with dual hydraulic power packages assisting with control surface movement at all ranges of travel. The aeroplane can be controlled manually with no assistance from the hydraulic system should that ever be necessary.

Battery Tools

POWER tools with attachments are not new and are still extremely popular, judging by the continued variety that pours from the makers. But tools that are driven by batteries and are definitely pocket-size are not so numerous, though some have appeared during the past year.

The Jiffytool, made by Ace Products, 12 Manette Street, London, W1, is based on a standard 3 volt torch vattery. It can be supplied as a complete kit including a ½ in flat carborundum wheel, a ¼ in rotary brush and a small mixing tool for stirring paint. Two U2 batteries drive the motor which gives tool speeds of the order of 5,000 r.p.m. The No. 2 kit is a more powerful set and is designed to work from a car battery, or from a standard 4½ volt cell. The kit includes the same tools as the No. 1 but there are over 50 different spare tools that can be added. Remarkably powerful for its size, the tool can be used for all light grinding, etching, polishing, and drilling, and for such car-service operations as cleaning sparking plugs and distributor points, as well as for cleaning connecting pins on radio

The Jiffytool is powered by two U2 batteries.

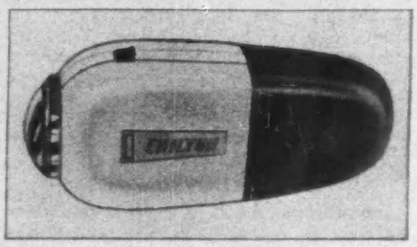
and television valves. The motor is replaceable, should it wear out.

The Jiffymix is a variant, designed for mixing drinks such as milk shakes and cocktails. It has a nylon spinner that is easy to clean. The Rotex range, available from the same firm, includes ten models, all battery driven. Among them are an egg whisk, silver polisher, fan, and, for the boudoir, a nail polisher and a denture cleaner. For the office, there is a typewriter eraser. Cases are supplied in a wide range of colours, including both single colours and two-colour combinations. The "Teeny-Weeny" is a combined torch and cigarette lighter.

A rechargeable battery powers the Acculux combination torch made by Chilton Electric Products Limited, Hungerford, Berkshire. It measures 3¾ in long by 1¾ in wide. Charging is extremely easy. The rear cap is pulled off and the two pins so exposed are plugged direct into a two-pin 5A socket. A full charge takes about 15 hours on a 200 V supply, but recharging can be carried out regularly for short periods to keep the battery topped up. With a weight of 3 oz the torch can be easily carried about in the pocket.

This appliance, too, has a range of accessories to extend its usefulness. A flash-gun attachment fits a standard camera shoe and provides both open and synchronised flashes. The unit includes a testing bulb. For testing the continuity of circuits, there is a probe attachment with a clip lead, and a flexible cable with a lamp at the end makes the Spylight for inspecting interiors or awkward corners. For holding the torch during working there is a suction pad that fits on the rear, gripping any flat surface and leaving both hands free.

For detail work a magnifier fits directly over the bulb head and gives an illuminated as well as a magnified view. With the magnifier go a thread counter and a front lens supplement that have many uses in the textile trades in particular as well as for general purposes. A reading glass



A rechargeable battery is used in the Acculux torch which has ten attachments. Below are shown the flash gun, suction holder, magnifier and reading glass.

of fourfold magnification is also available. Three rather unusual accessories make up the full range. They have particular uses in the medical profession and are a throat spatula, an otoscope and a dentist's mouth torch. They follow the standard designs of these instruments and supply the illumination so often needed for close inspection under normal conditions. A sterilising stand is supplied for the throat spatula and the dental kit.

Even carving can be made easy this year for there is news of a carving knife which has batteries in the handle to reciprocate the blade. Saw or plain knife blades can be used alternatively.

END OF 190th VOLUME

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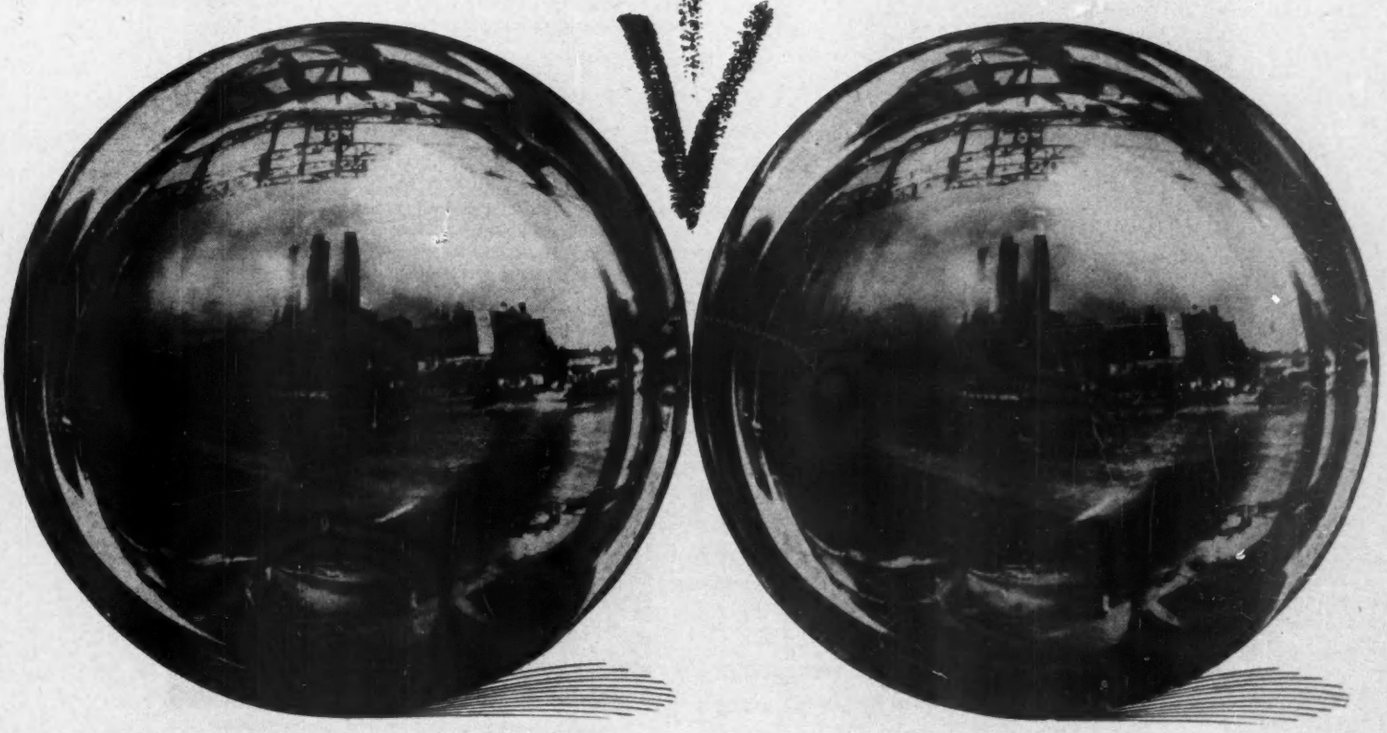

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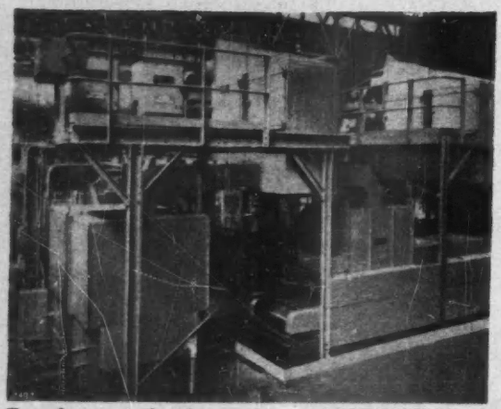

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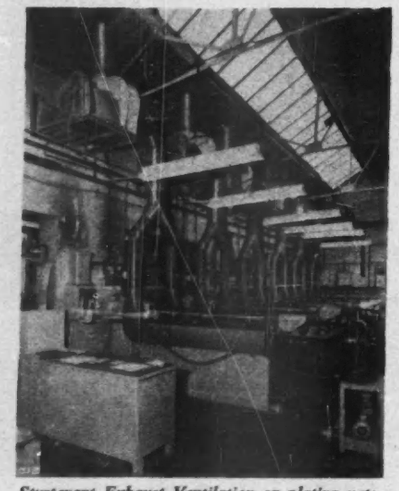
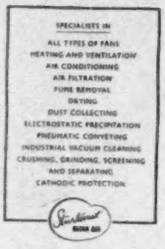


Sturtevant Exhaust Ventilation on plating vats at the Decca Record Co. Ltd. Ducting and fan casings are of PVC and impellers are coated with acid-resisting material.

Particulars of Sturtevant Exhaust Ventilation are contained in publication D3604



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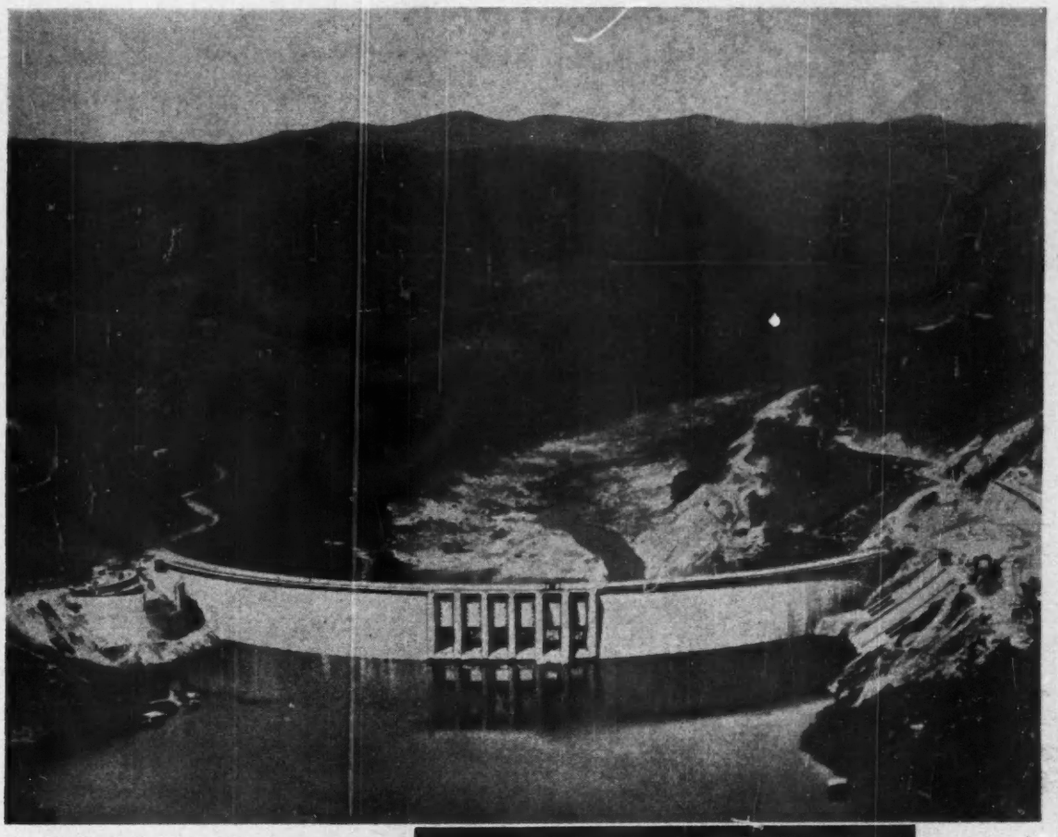

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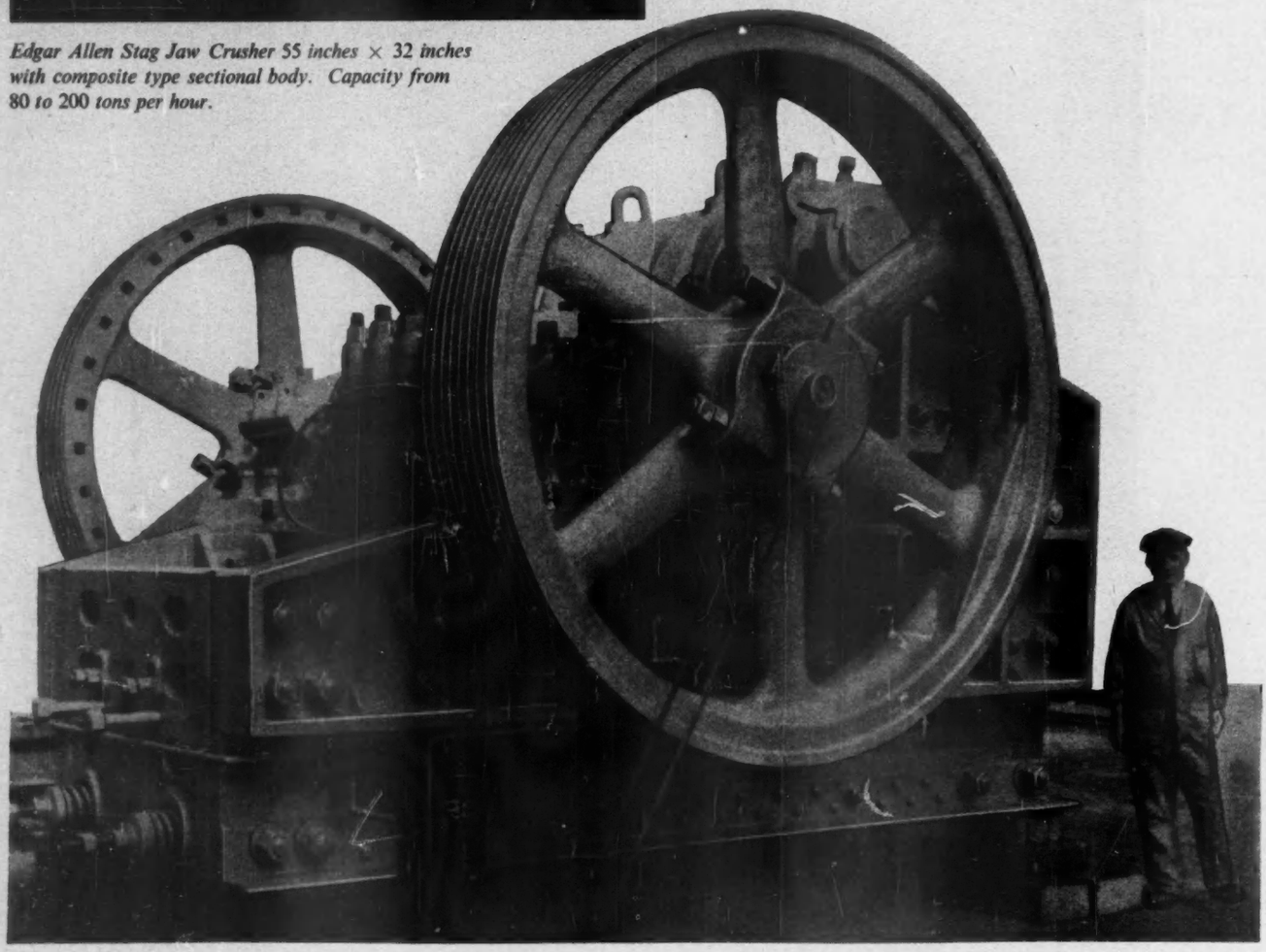

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TARIFF FOR BULK SUPPLIES TO AREA BOARDS

fixed by the Central Electricity Generating Board (the Generating Board) pursuant to section 37 (1) of the Electricity Act, 1947, for the year ending 31st March, 1962

NORMAL KILOWATT CHARGE

£7.7.0d. (seven pounds seven shillings) for each kilowatt of the number ascertained by multiplying by 26,350,000

the maximum number of kilowatts determined by deducting from the **half-hour kilowatt demand** supplied to the Area Board the **half-hour kilowatt demand** of the **special consumers** in the same half-hour and adding the sum of the **nominated firm kilowatts** and the **excess kilowatts** (if any) of the **special consumers**

and dividing the product by

the sum of the said maximum number of kilowatts for each Area Board and the chargeable kilowatts in the year of other direct consumers of the Generating Board.

RESTRICTABLE KILOWATT CHARGE

The above Normal Kilowatt Charge less £4.2.0d. (four pounds two shillings) for each kilowatt of the sum of each maximum **half-hour kilowatt demand** of **special consumers** less the sum of their **nominated firm kilowatts** and less the sum of their **excess kilowatts** (if any).

For the above purposes—

(i) **"the half-hour kilowatt demand"** means twice the number of kilowatt-hours supplied in any half-hour between 7.0 a.m. and 7.0 p.m. on any Monday, Tuesday, Wednesday, Thursday or Friday, or between 7.0 a.m. and 12.0 noon on any Saturday in the year.

(ii) **"special consumer"** means a consumer of the Area Board who has agreed that (without prejudice to any statutory right which the Area Board may have to discontinue the supply of energy) his kilowatt demand can be restricted by the Generating Board for up to 2 hours on any occasion and up to an aggregate of 50 hours in the year provided that

(a) The supply is afforded to the consumer's premises directly from a generating station or substation of the Generating Board through circuits not used for supplies to other consumers.

(b) The difference between the consumer's maximum **half-hour kilowatt demand** and his **nominated firm kilowatts** shall be not less than 25,000 kilowatts.

(c) Suitable provisions have been made in respect of the costs of connection and the technical arrangements for operation, control, and metering, which may vary with local circumstances, and

(d) Prior agreement has been made between the consumer, the Area Board and the Generating Board in each case.

(iii) **"Nominated firm kilowatts"** means the **five minutes kilowatt demand** which in accordance with the above arrangements the **special consumer** is entitled to make during a period of restriction. For this purpose **"five minute kilowatt demand"** means twelve times the number of kilowatt-hours supplied to the **special consumer** in any consecutive five minutes.

(iv) **"Excess kilowatts"** means the amount by which the **nominated firm kilowatts** is exceeded by twelve times the largest number of kilowatt-hours supplied to the **special consumer** in any five minutes (excepting the first five minutes) during any period commencing when the Generating Board indicate (by a signal or otherwise) that they require his demand to be restricted in accordance with the above arrangements, and ending when the Generating Board indicate that normal supply may be resumed.

RUNNING CHARGE

0.42d. (decimal four two of a penny) for each kilowatt-hour supplied during the year, this charge to be increased or reduced by 0.00055d. (decimal nought nought nought five five of a penny) for each penny (a halfpenny or any greater part of a penny being treated as a penny) by which the fuel cost per ton in the year shall be above or below 60s. (sixty shillings).

For this purpose—

(i) **"Fuel cost per ton"** in any period shall be **either**

(a) the quotient produced by dividing the aggregate of the product of the **Area fuel cost per ton** in the period and the **number of kilowatt-hours supplied from generation in the Area** in the period, and the product of the **residual cost per ton** in the period and **the number of kilowatt-hours imported into the Area** if any in the period by **the number of kilowatt-hours supplied in the Area** in the period; or

(b) **the Area fuel cost per ton;**
whichever is the less.

(ii) **"The Area"** means the Area of the Area Board taking the supply.

(iii) **"The Area fuel cost per ton"** in any period shall be determined as follows: the total **cost of fuel consumed** in the period at all the Generating Board's stations in **the Area** shall be divided by the total number of tons of **fuel** so consumed and the cost per ton so obtained shall be multiplied by 11,000 and divided by the average gross thermal value of **fuel** so consumed expressed in British thermal units per pound.

(iv) **"Fuel"** shall mean coal, coke and oil fuels but shall not include atomic fuels.

(v) **"The cost of fuel consumed"** shall mean the sums expended for **fuel** consumed plus the cost of any transport, handling preparation or treatment incurred in connection with the delivery of the **fuel** to boiler hoppers or furnaces and in connection with the disposal of the products or residues of combustion, together with the proper proportion of salaries and wages and any contributions for pensions, superannuation and insurance of officers and servants attributable thereto and the amount of any rebate allowed by the suppliers from the price of heavy fuel oil delivered at the Generating Board's stations, such rebate being attributable only to a specific quantity of heavy fuel oil so delivered, less any sums received from the sale of any products or residues of combustion.

(vi) **"The number of kilowatt-hours supplied from generation in the Area"** in any period means the number of kilowatt-hours (being kilowatt-hours generated by the combustion of **fuel**) sent out from all the stations of the Generating Board in **the Area** in the period or **the number of kilowatt-hours supplied in the Area** in the period whichever is the less.

(vii) **"The number of kilowatt-hours supplied in the Area"** in any period shall mean the number of kilowatt-hours supplied in the period by the Generating Board to the relevant Area Board and to other consumers in **the Area.**

(viii) **"The number of kilowatt-hours imported into the Area"** means the amount if any by which **the number of kilowatt-hours supplied in the Area** exceeds **the number of kilowatt-hours supplied from generation in the Area.**

(ix) **"The residual cost per ton"** in any period shall mean the aggregate of—

(A) the quotient produced by dividing the amount by which **the national fuel cost per ton** in the period multiplied by the aggregate of **the number of kilowatt-hours supplied in the Area** of each Area Board in the period exceeds the aggregate of the respective products in the case of each Area Board of (a) **the Area fuel cost per ton** in the period and (b) **the number of kilowatt-hours supplied from generation in the Area** in the period, by the aggregate of the **number of kilowatt-hours imported into the Area** of each Area Board in the period; and

(B) the sum of 6s. (six shillings).

(x) **"The national fuel cost per ton"** in any period shall be determined as follows: the total **cost of fuel consumed** in the period at all the Generating Board's stations shall be divided by the total number of tons of **fuel** so consumed and the cost per ton so obtained shall be multiplied by 11,000 and divided by the average gross thermal value of the **fuel** so consumed expressed in British thermal units per pound.

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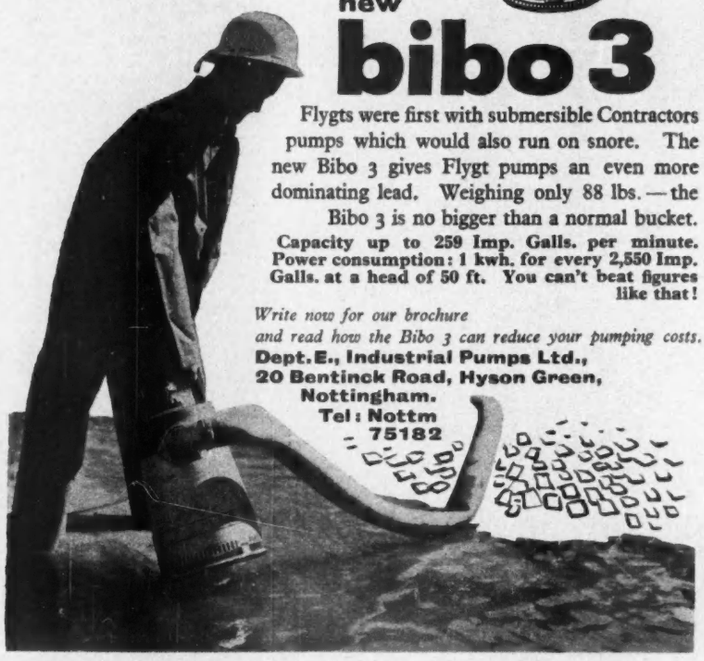

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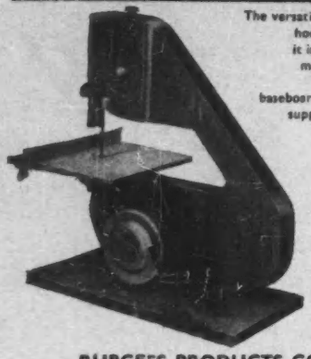

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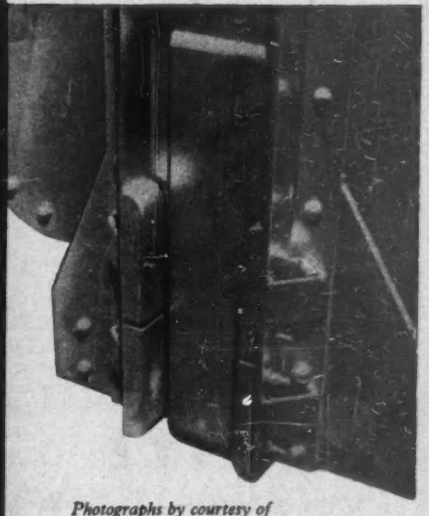

Photographs by courtesy of Wabi Iron Works Ltd, Ontario show how guide shoes were fitted.

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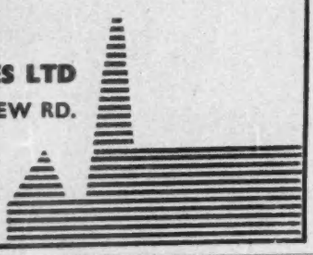

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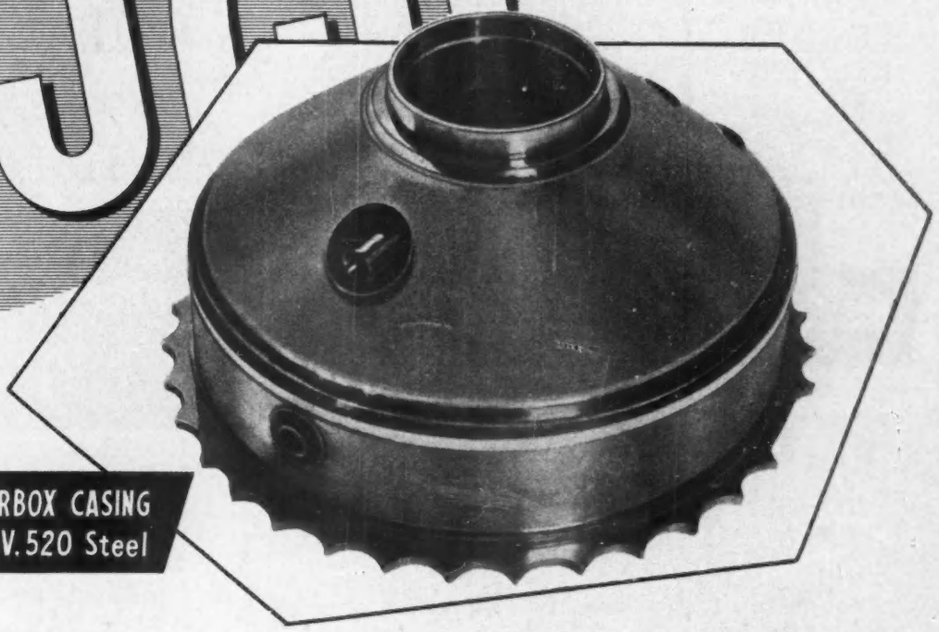

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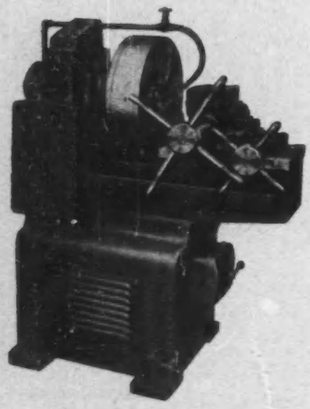

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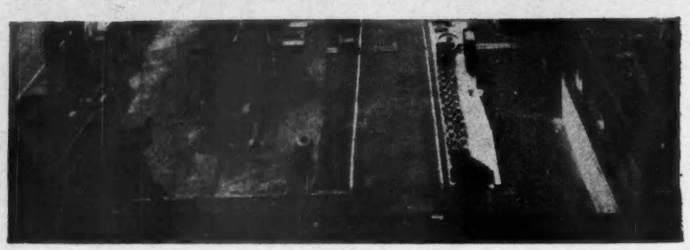

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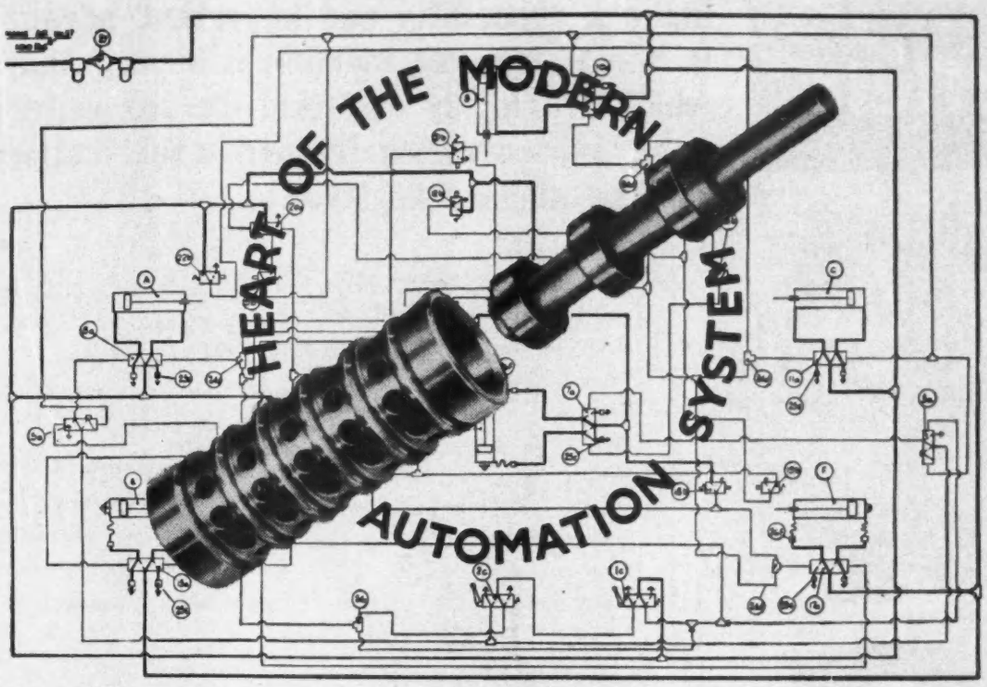

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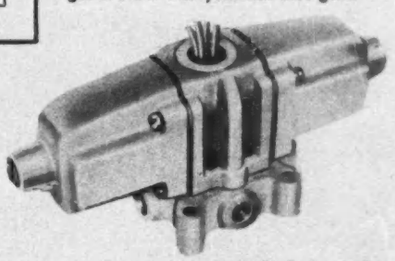

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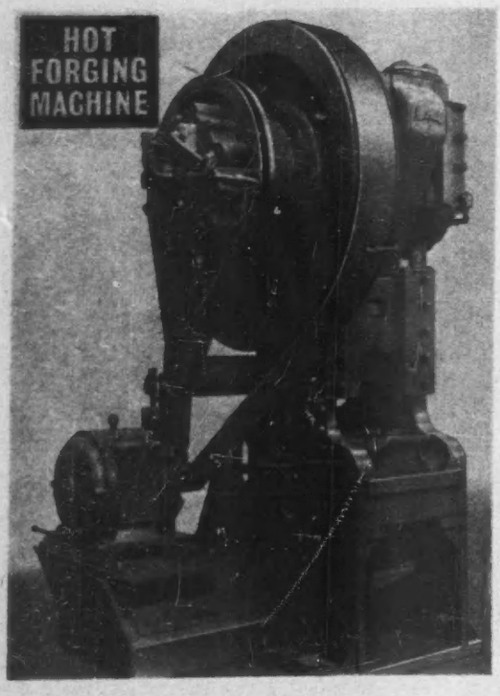

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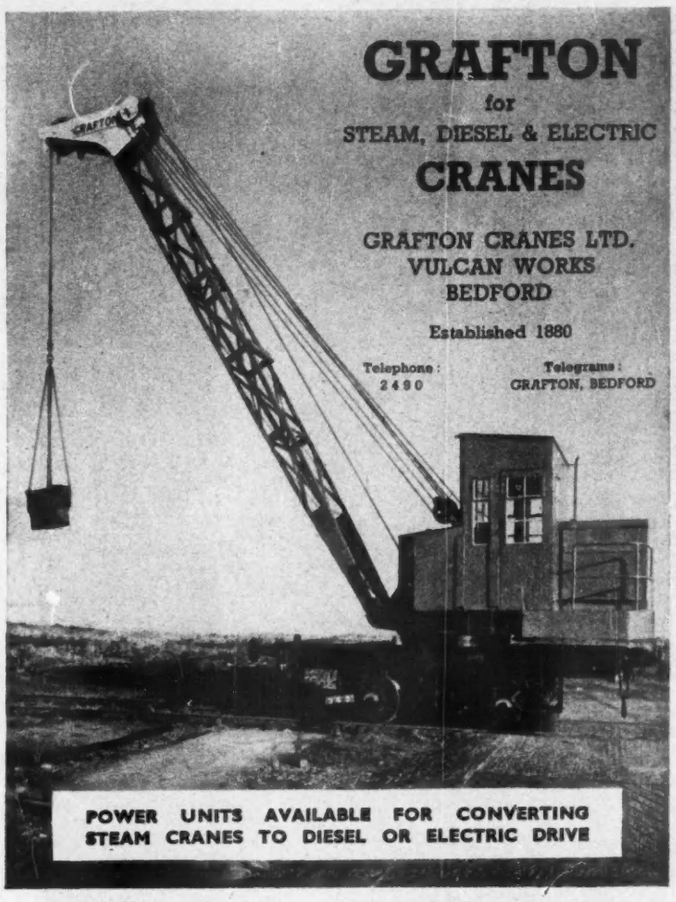

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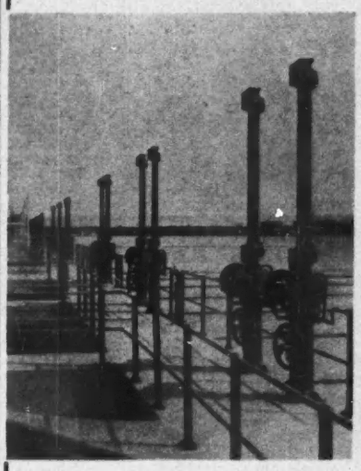

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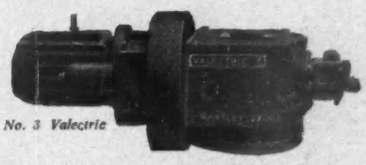

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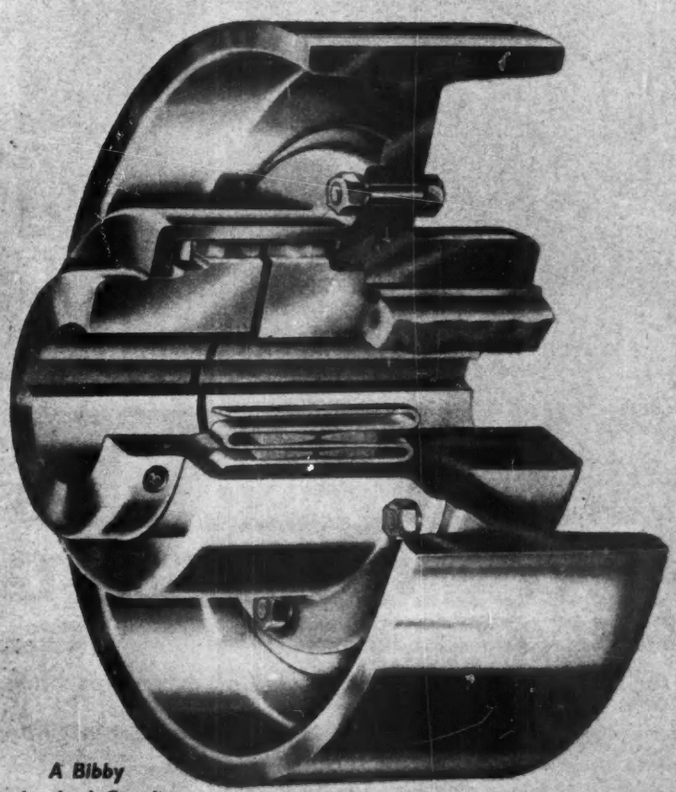

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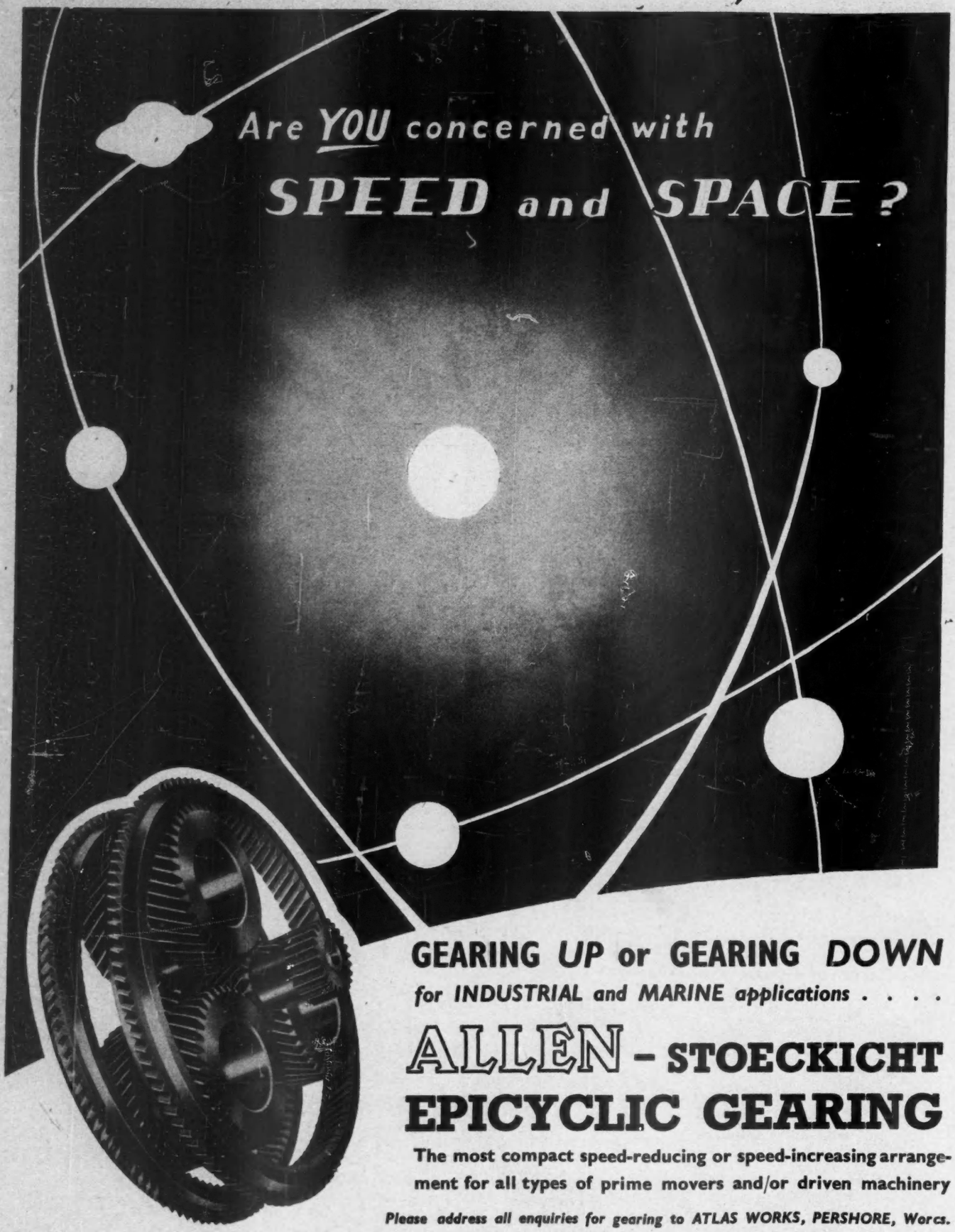

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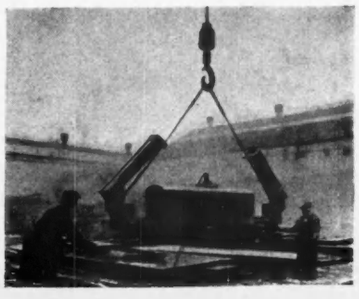

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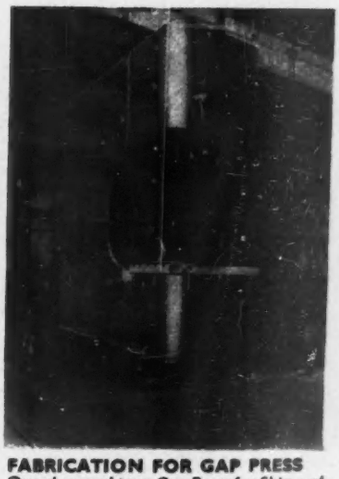

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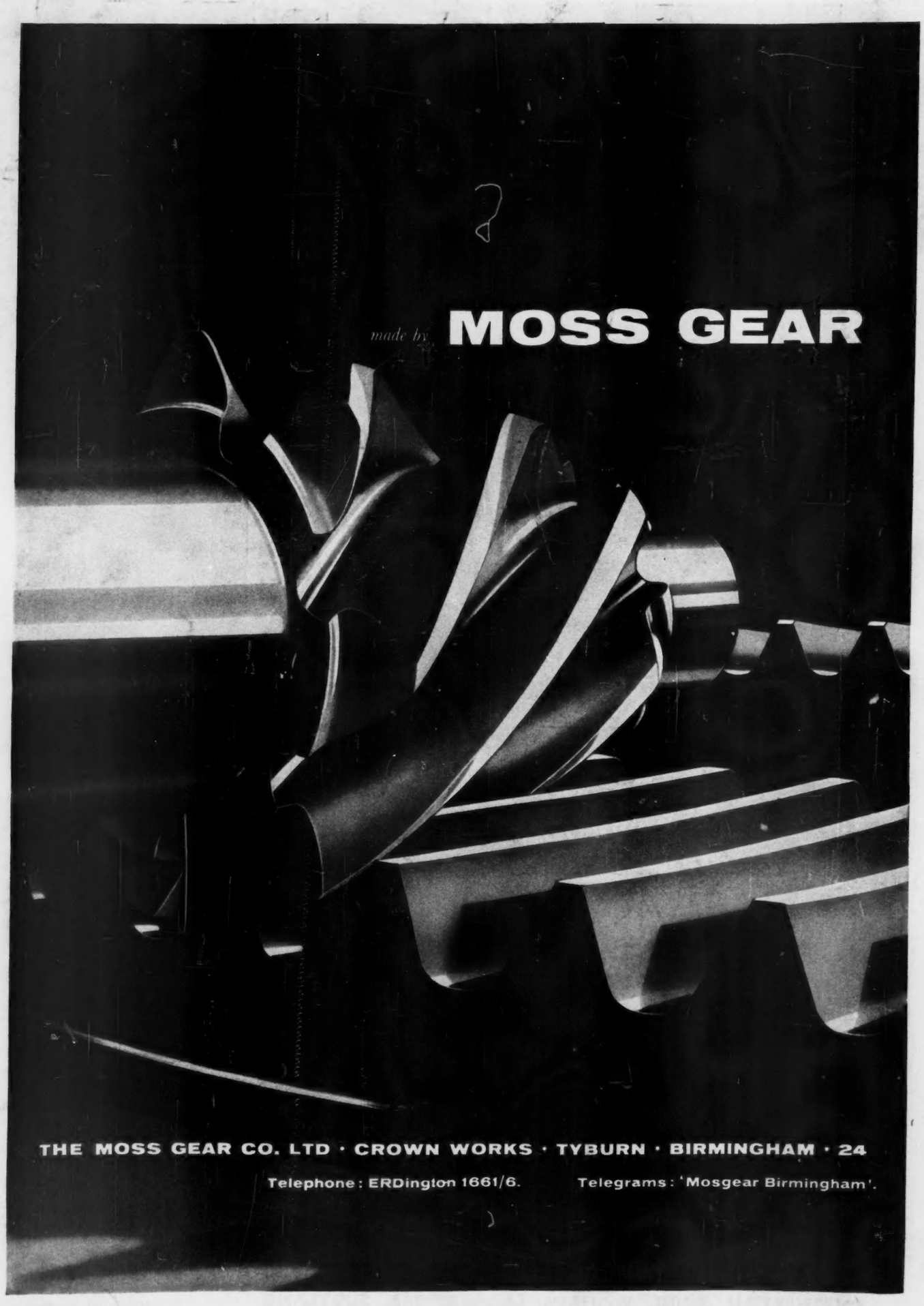
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